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USING PNEUMATIC BACKFILL TAMPERS TO RAM DIRT IN A TRENCH AFTER THE LAYING OF GAS PIPE

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SEPTEMBER, 1922

Artificial Ice in the Ascendency

Increased Mechanical Efficiency Working Wonders in the Making of Ice

By ROBERT G. SKERRETT

ARE THE days of the ice-house numbered? We are told they are. And persons qualified to speak go to some length to give us the details of the decadence of this time-honored source of comfort in the months when the sun shines hottest.

Offhand, this is a disquieting prediction, for refrigeration, using the term in its broadest sense, means more today to Americans than to the people of any other nation. What should we do without the tinkling tumbler; what would take the place of that plenty of cracked ice to which we are accustomed; and how should we preserve afresh the great varieties of foodstuffs that continually form a liberal portion of our dietary?

And yet, it is undeniably true that the commercial ice-house is less in evidence now than ten or twenty years ago. Of course, ice of Nature's forming will probably be utilized as heretofore in those localities where the colder winter freezes over ponds, lakes and rivers, but its distribution afar from these places of abundance is steadily declining. It was not so far back when the natural ice industry of Maine was a booming activity. In the decades gone, the great ice-houses reared along the Kennebec River were the stores from which ice was shipped to distant points southward along the coast as well as inland.

At the present time but few of these structures are standing, and those remaining supply their cooling commodity to a much more limited area than in the past. Again, the numerous ice-houses on the Hudson River have ceased to be of the same vital concern to the teeming populace of the Metropolitan Zone; and we are informed that five years hence probably none of them will send any of their ice down to Greater New York.

Don't let this trend worry you, for the average citizen will be better off in the days to come than in the years gone when the entire annual ice supply varied with the character of the winter season. This promising outlook is due to the fact that the art of the refrigerating engineer has made tremendous strides in the last decade. Science is steadily supplanting Nature, and has rendered it practicable to manufacture ice at anytime and well-nigh anywhere of a quality often distinctly superior to the product of pond or river. Not only that, but there are vast areas within this country of ours where ice of man's making can be sold a good deal cheaper than ice of Jack Frost's fashioning delivered there from far-away sources. This seeming paradox is one more evidence of how the modern refrigerating engineer can turn natural laws to his own account and defy Nature at the same time.

FEW PEOPLE realize the magnitude of America's ice-making industry. The public at large imagines that most of the ice for refrigerating purposes is still garnered from our ponds, lakes, and rivers during the frigid months of each year. This is not the fact; and in some of our large municipalities anywhere from 50 to 85 per cent of the ice used is of the so-called machine-made kind.

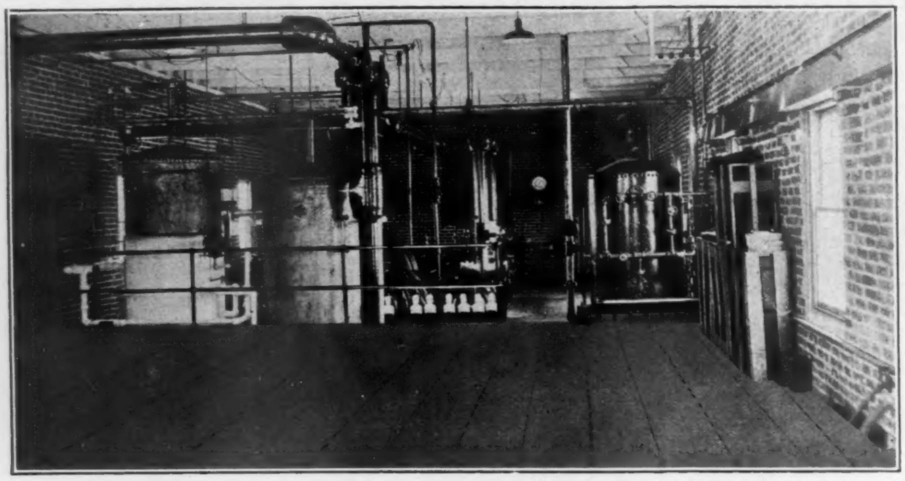
During 1921, the country's commercial ice-manufacturing establishments produced substantially 40,000,000 tons of this commodity, representing an aggregate value of not less than $200,000,000. The money invested in this business now exceeds $450,000,000; and expansion is the order of the day because of the wide field of service in which refrigeration plays a prime part.

Many men and many minds have devoted their best efforts to perfecting ice-making apparatus; and the object of the present article is to tell something about the significant accomplishments that have latterly been effected in this truly fascinating department of engineering.

It is doubtful if the populace at large have more than a hazy notion of the extent to which so-called artificial ice contributes to their comfort, convenience, and general well-being. Half a century back, there were only three ice-manufacturing plants in the United States; and in 1900 there were but 242. At the present time there are more than 5,000 installations of this kind, not including the small ice-making equipments of restaurants, hotels, hospitals, produce houses, etc., etc., which, individually, have daily capacities of a ton or less.

During the past year, the commercial ice-manufacturing establishments turned out about 40,000,000 tons of the commodity; and this product, at an average price of $5 a ton, represented an aggregate value of $200,000,000. We are authoritatively informed that the investment in this business has now reached a sum exceeding $450,000,000. Impressive as these figures are, they should not surprise us if we pause for a moment and consider the situation in some of our big cities. For example: In New York, only 40 per cent. of the ice consumed is the natural article; in Philadelphia, 85 per cent. of the ice used is manufactured; and from Philadelphia south substantially all of the ice marketed is machine-made. The per capita consumption varies in different municipalities, and ranges all the way from 600 pounds to 2,000 pounds annually, so an expert declares.

The making of ice by machinery seems little short of a miracle to the uninitiated; and the purpose of the present article is to make plain how this is done and to show how certain developments in the art have increased the efficiency of the apparatus employed. Most of us know that the steam engine converts heat into mechanical work. The refrigerating machine, on the contrary, first transforms mechanical energy into heat, and then utilizes the latter to



Photos Courtesy, Van R. H. Greene Co.

The engine room and the freezing tank room of an electrically-operated ice plant. The freezing tank is the covered portion in the foreground.

produce cold. In short, the ice-making machine is really only an agency in juggling with latent heat so as to promote a chilling reaction of more or less intensity. Therefore, let us understand the character of latent heat.

The term latent heat is applied to that measure of heat which is either absorbed or surrendered by a substance when that substance is undergoing a change of state without actually experiencing an alteration of temperature. We have an example of this process every time ice-cream is made in the domestic freezer. If a pound of ice, for instance, at a temperature of 32 degrees Fahrenheit, is melted into water, also of 32 degrees Fahrenheit, the water absorbs 144 heat units. Therefore, in producing ice-cream, if we induce melting by mixing salt with the ice, the water will withdraw heat units from the cream within the can; and when we have carried this procedure far enough the cream will congeal. Similarly, a gas that has been liquefied by pressure, and which is next allowed to become gaseous again, will, when gasifying, extract a large amount of heat from near-by bodies.

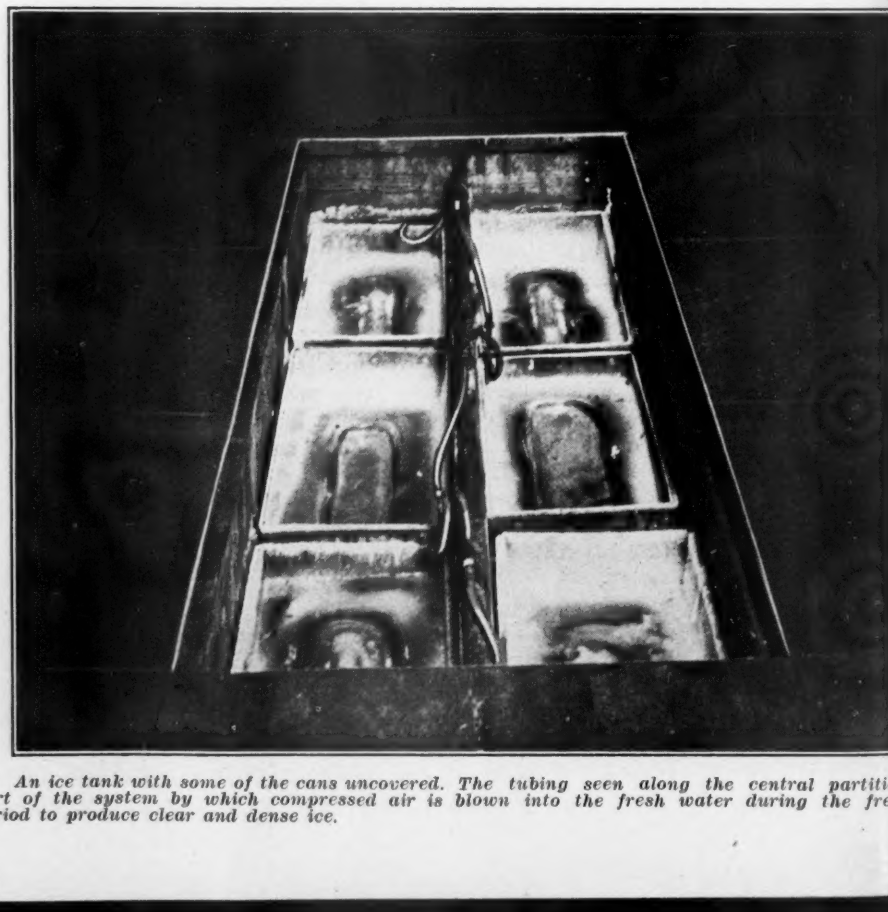
Some gases liquefy more rapidly than others; and for refrigerating purposes ammonia is the one most generally used. This ammonia, in its liquid state, is sold in drums holding 100 pounds of the stuff. It is called anhydrous ammonia because it is entirely free of water and, therefore, 100 per cent. strong. Liquid ammonia, at a temperature of 90 degrees Fahrenheit and at a pressure of 180-odd pounds, on expanding into gas will take up from an external source quite 465 thermal units. Now let us see how these facts are applied in the manufacture of ice by the compression method.

The ice machine is an adaptation of the air compressor to the specialized needs of refrigeration; and in describing the operative cycle we shall start with this apparatus so that we can get a clearer comprehension of the various steps. The compressor draws into its cylinder gaseous ammonia, compresses it in one or two stages, and discharges it at a pressure ranging from 180 to 185 pounds to the square inch. Still in its gaseous condition, this compressed ammonia, at a temperature ranging between 250 and 300 degrees Fahrenheit, is then delivered to a condenser consisting of a series of coils of piping over which water falls. This water cools and condenses the gaseous ammonia, and in liquefying it the water robs the ammonia of heat units.

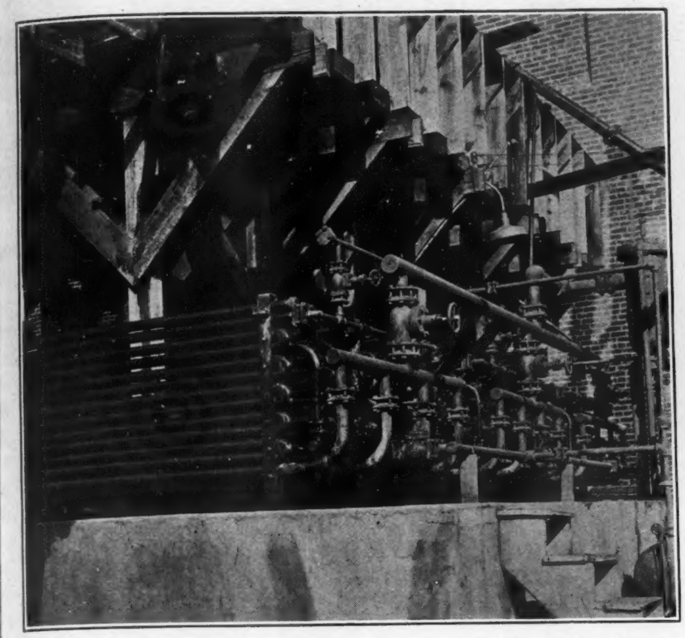
The liquefied ammonia, at a temperature of about 90 degrees Fahrenheit, passes from the condenser to a tank called a receiver; and from the receiver, at a pressure of 180 pounds, the liquid ammonia is piped to an expansion valve, whence it is led to a refrigerating coil. Upon issuing from the expansive valve, which is really a pressure-reducing valve, the pressure of the ammonia drops suddenly to about fifteen pounds, and this reduction vaporizes some of the liquid —the amount being that necessary to cool, by its expansion, all the remaining liquid to the temperature corresponding to its new lower pressure. If this new pressure is fifteen pounds gage, then the temperature will be O degrees Fahrenheit, which is the boiling point of liquid ammonia at fifteen pounds gage. But the change of state is for the moment only partial because gasification of the ammonia calls for the reabsorption of the heat previously extracted from the chemical, and this is purposely checked by carefully insulating the piping through which the ammonia is led from the expansion valve to the refrigerating coil

In an ice-making plant, the bare refrigerating coil is immersed in a mixture of salt and water and there the ammonia is free to complete its gasification and to take from the brine a large quantity of heat units. As a result, the temperature of the brine, in the most efficient installations, is lowered to 14 degrees Fahrenheit, and fresh water, in cans set in the saline solution is, in its turn, robbed of its heat by the brine and frozen. The gaseous ammonia, on leaving the expansion coil in the brine tank, goes to the compressor, thus finishing the refrigerating cycle; and in this way the ammonia is used over and over again. It should be noted that the ammonia at no time comes in contact with the fresh water and, therefore, can not affect its taste. Furthermore, the purity of this water can be assured.

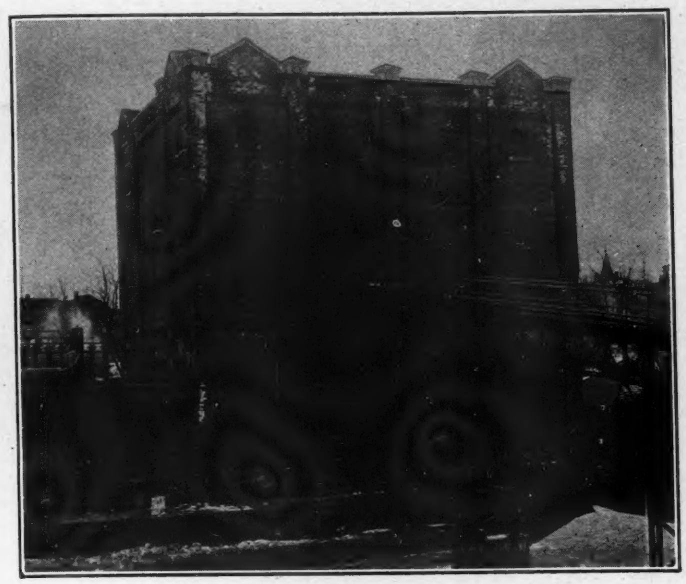
Now let us see how the principles and the steps just described have been utilized and improved upon in some directions in the upbuilding of the ice-making industry, as we have it to-day. Perhaps the story can best be told in the words of Van Rensselaer H. Greene, a prominent refrigerating engineer of New York City. "Prior to 1912, all ice plants used distilled water, because it was then believed that water of this sort was necessary in order to obtain a hygienic product. In those days, the prime mover was a steam engine, and the exhausted steam was condensed and used to supply most of the distilled water—the rest of the water, which was considerable, being derived from



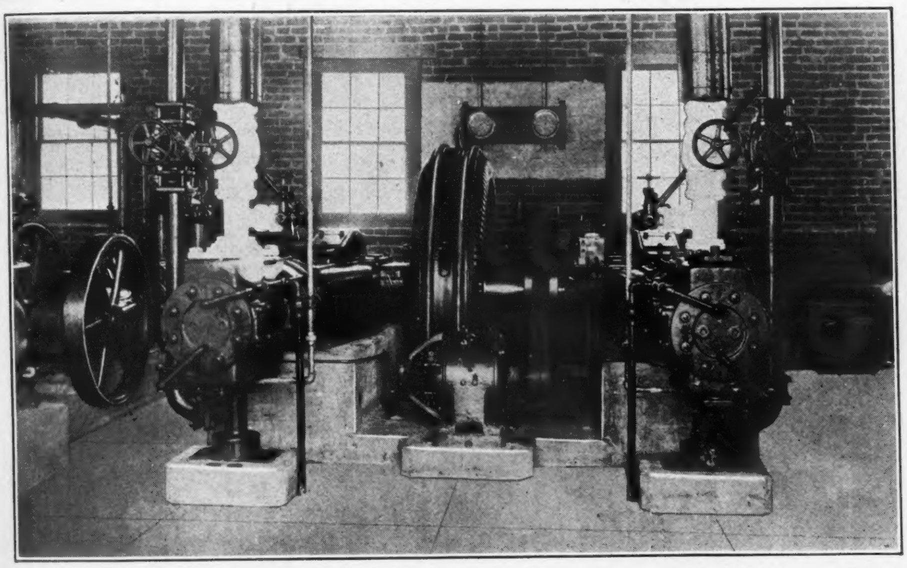
An ice tank with some of the cans uncovered. The tubing seen along the central partition is part of the system by which compressed air is blown into the fresh water during the freezing period to produce clear and dense ice.



Coils of ammonia condensers set below the water-cooling tower.

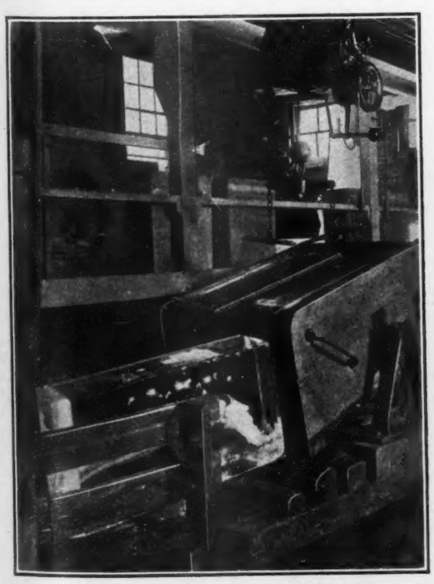


The 5,000-ton ice-storage building of an ice-making plant.

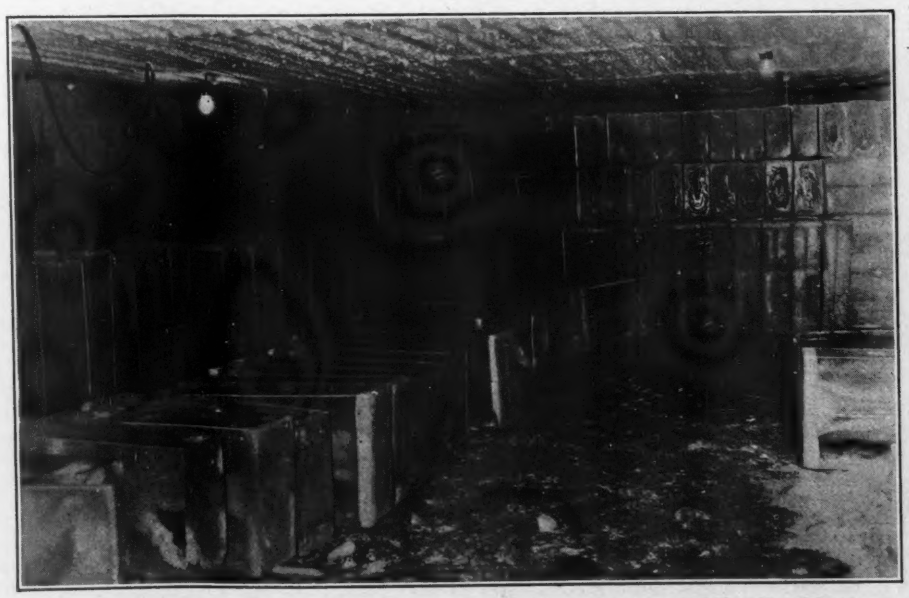


A close-up of an electrically-driven ammonia compressor.

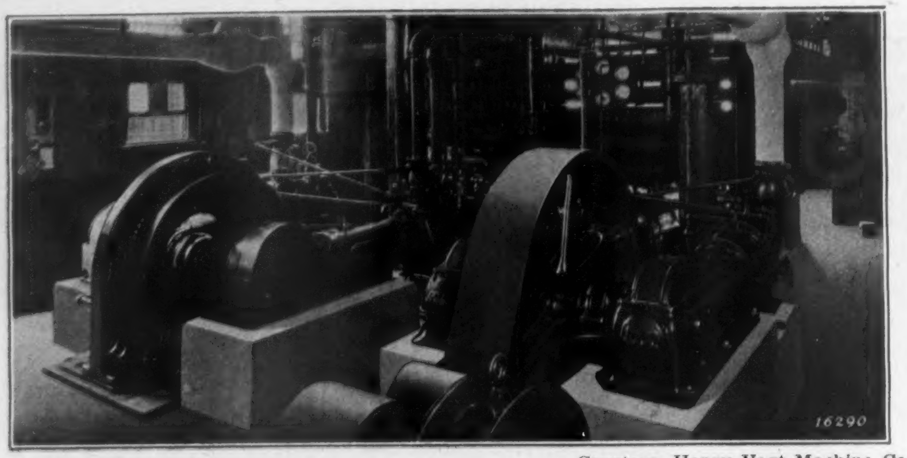
The dehumidifiers of an ice plant. Owing to the low temperature at which the air-agitation system works it is necessary to remove the moisture from the air to prevent the freezing or clogging of the distributing pipes.



The ice dump. This tipple is arranged to handle two cans at a time.



The daily storage room of an ice-making plant. The ice is temporarily placed here on coming from the tank room.



Courtesy, Henry Vogt Machine Co.

Large direct-connected, synchronous, motor-driven, two-stage ammonia compressor and belted ammonia compressor installed at Merchants' Ice & Cold Storage Co., Louisville, Ky.

steam passing directly from the boiler to the condenser. A plant of that kind was anything but economical in fuel consumption, measured by the output of marketable ice; and because of the difficulties incident to the skimming of oil from exhaust-steam water, the ice, not infrequently, had an objectionable flavor, and always a flat taste. Not only that, but disease germs survived the processes of manufacture and caused sickness when the ice was subsequently broken up and put in drinking water, etc.

"Distilled-water ice plants have never, even under the most favorable conditions, been able to make more than five pounds of ice for each pound of coal burned under the boilers; and so long as the artificial ice industry depended upon this system its commercial success was very limited. Indeed, it managed to survive mainly because fuel was comparatively cheap in those days. The manufacture of ice took on a new lease of life when, a while back, we turned our attention to the utilization of raw water, the kind furnished us by city mains, springs, and artesian wells. From that time on the business has grown tremendously. With proper safeguards, such as would normally be exercised in regard to the drinking water of any up-to-date community, thoroughly palatable ice can now be made by machinery which is often purer than the ice of Nature's forming and fully as good as a refrigerant.

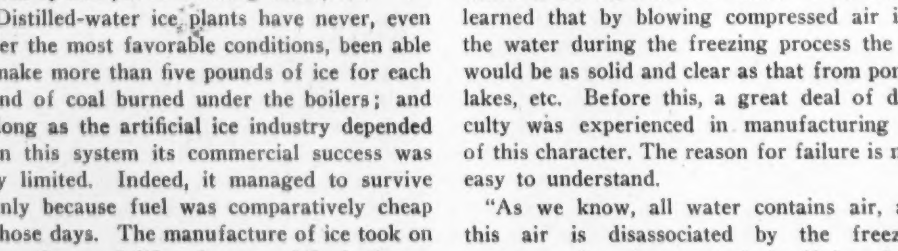
"Probably one of the biggest strides forward was the outcome of a discovery made about ten years ago, which bears directly upon the artificial production of sound ice as distinguished from the white or snowy commodity which is of little market value. It was then learned that by blowing compressed air into the water during the freezing process the ice would be as solid and clear as that from ponds, lakes, etc. Before this, a great deal of difficulty was experienced in manufacturing ice of this character. The reason for failure is now easy to understand.

"As we know, all water contains air, and this air is disassociated by the freezing process and tends to attach itself in minute bubbles upon the surface of the growing cake during ths stages of freezing. These bubbles break up the normal crystalline structure and would cause an opaque block if this action were not arrested. A continuous washing of the forming surfaces is needed to drive off the clinging air particles; and this is now accomplished by a steady rising stream of agitating air from the bottom of each can. The air used for this purpose is discharged at a pressure of about two pounds from suitable fittings inserted in the cans; and these attachments are located where they do not interfere with the subsequent dumping of the blocks of ice out of the containers.

"The success of the ice-making industry today is essentially a problem of economy and the skilful adaptation of a plant's capacity to meet the varying demands of different seasons. The latest and the most significant mechanical contribution to this end is the compound ammonia compressor. Compressors of a 2-stage type, capable of efficiently handling air and other gases, have been on the market for a long while, but the engineering world has been compounding ammonia for the brief span of only two years. The compound ammonia compressor is capable of effecting a saving in consumption of power; and power, in the last analysis, is the factor which determines whether ice can be manufactured at a loss or at a satisfactory profit."

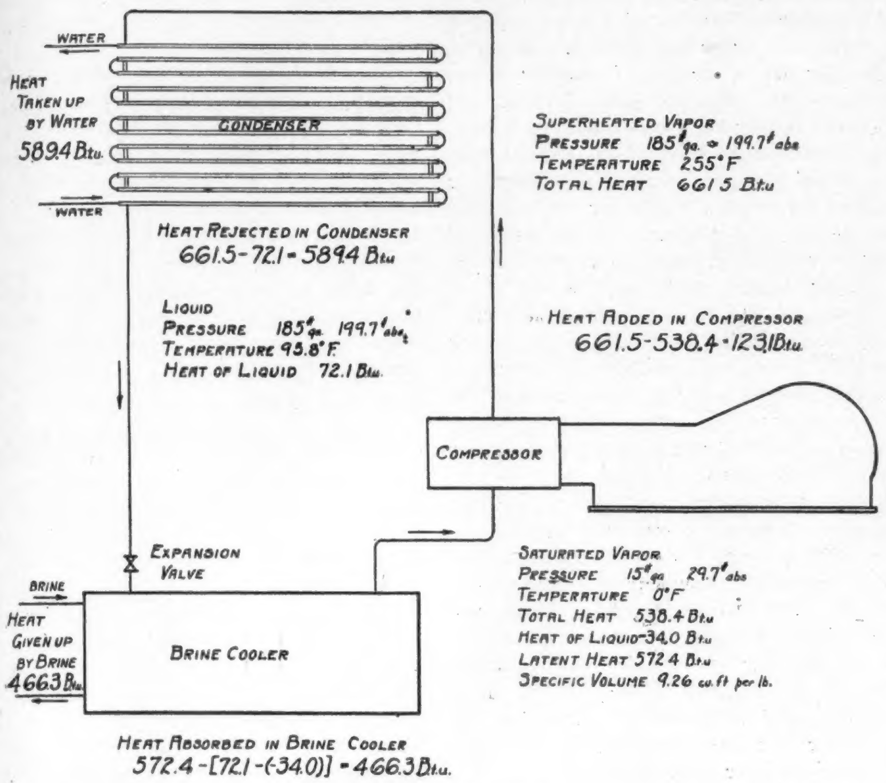
Most ice plants work at capacity during the warm months, but the business usually drops off during the other seasons, especially throughout the months of December, January and February; and then the question is how to operate these establishments economically. This is particularly puzzling if the machines are actuated electrically, for with current rates fixed, and with charges further based upon the maximum load factor shown by the meter at any time during a week or a month, there is a more or less costly penalty for peak loads no matter how brief their duration. The problem, therefore, is to control the consumption of current and to make the load line more nearly uniform while keeping it in closer accord with the actual yield of ice. The ever-widening adoption of electric drive in the ice-making industry has emphasized the importance of the employment of equipment which will hold the cost for current at a minimum. The latest patterns of compound ammonia compressors do this; but before describing the features that render this feasible, let us understand the general situation in the business.

In New York City there are three big plants which, on a basis of their total output during 365 days a year, produce from 84 per cent. to 92 per cent. of their capacities. This is possible because the large winter load, when natural ice does not enter the market, is substantially the same as the summer load when natural ice is available; and the demand is therefore stabilized so far as the machine product is concerned. On the other hand, the average ice plant, the country over, has an annual load of approximately 65 per cent. of its capacity; and to earn money upon the investment the installation must be able either to keep its electrical charges commensurate with production or to operate in excess of seasonal requirements and have at hand a storehouse for its surplus ice. Be the choice what it may, the showing will be on the right side of the



The accumulator of an ice-making plant. The purpose of the apparatus is to effectively separate liquid ammonia from the gaseous ammonia passing on to the compressors. Otherwise slugs of the liquid ammonia might reach the cylinders of the compressors and cause damage.

Refrigeration Cycle for 15# Suction, 185# Discharge



HEAT BALANCE

Heat Added to One Pound of Ammonia		Heat Subtracted from One Pound of Ammonia	
In brine cooler	466.3 B. T. U.	By Cooling Water in Condenser	589.4 B. T. U.
In compressor	123.1 B. T. U.		
	589.4 B. T. U.		

EQUIVALENT REFRIGERATION

B. T. U. refrigeration per pound of ammonia	466.3
"Tons refrigeration" per pound of ammonia per minute	466.3 ÷ 200 = 2.33
Cubic feet per minute of ammonia for one-ton refrigeration	9.26 ÷ 2.33 = 3.97

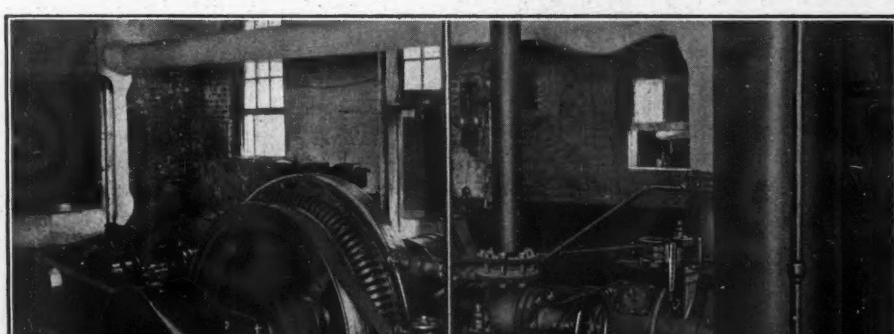
ledger only if the most efficient ammonia compressors are provided.

While the aim of the refrigerating engineer is to design plants that will make twenty tons of ice for every ton of coal burned under the boiler, most of these up-to-date establishments attain an average performance of fifteen tons of ice for each ton of coal consumed; and where the machinery is driven by electricity instead of steam, the consumption of current during the very active summer months ranges from 55 to 65 kilowatt-hours per ton of ice. Wherever current can be purchased at a suitable price, a lower initial investment is called for to equip an electrically-operated plant than one of identical capacity which relies upon steam as a primary source of motive energy. Further, substantial economies can be realized by adopting high-speed, direct-connected compressors. But there could be no economies without some provision to hold the consumption of current in close agreement with the load factor. This is by no means the case with compressors generally, whether of a simple or a duplex type, when hooked directly to a constant speed motor.

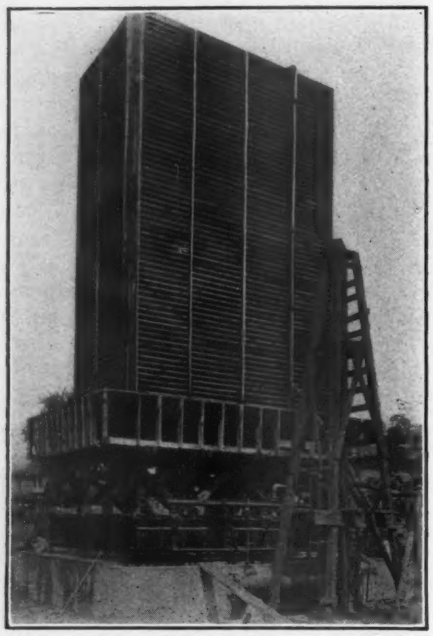
The purpose of this article, which is intended primarily to reveal the extent of America's ice-making industry, does not permit any intimate consideration of the mechanical features used in the modern ice plant; but in order to understand what has been achieved latterly by the technicists, we shall have to explain broadly wherein the compound compression machine is distinguished from those previously employed. One does not have to have more than an elementary idea of a compressor to grasp that at every revolution, depending upon the internal capacity of the cylinder and the travel of the piston, so much air or gas is drawn in at one stroke and discharged at the other. Therefore, in ordinary practice, it is customary to adjust the speed of the compressor agreeably to the desired output. How, then, you will ask, can the volume of discharge be varied to suit different needs if the compressor be direct-connected to a constant speed motor? The answer is, by "clearance pockets."

Clearance pockets are chambers outside of a cylinder which can be put in communication with the latter at the will of the operator; and they thus provide a simple means by which the volumetric capacity of the cylinder can be increased over its normal capacity. Therefore, the amount of ammonia, for instance, drawn in at the suction stroke and sent on into the line at the discharge stroke, is reduced in proportion to the "dead space" represented by the number of clearance pockets that are open to the cylinder. In a duplex or compound compressor, each ammonia cylinder has two clearance pockets. When working at three-quarter load, one pocket is open to each cylinder, and at half load both pockets on both cylinders are open.

The operation of this arrangement of clearance pockets is as follows: with the compressor running at partial capacity, a portion of the gaseous ammonia is forced into the augmented clearance space offered by the pockets instead of outward through the discharge valves. On the return stroke, this gas, which has been compressed into the pockets, has a chance to expand



Modern direct-connected, synchronous, motor-driven, two-stage Ingersoll-Rand ammonia compressor installation. The vertical water intercooler shown at right cools the ammonia gas between stages of compression.



Specially designed tower to cool water for ammonia condensers.

and to give up its stored energy—thus helping to move the piston and to lessen the load upon the electric motor. The inlet valves remain closed until the cylinder pressure has dropped to that of the intake pressure. Then, the inlet valves open automatically owing to a slight difference of pressure; and free gas is admitted for the remainder of the return stroke. In this way, the capacity of the compressor is reduced without lowering the intake pressure.

The clearance valves are susceptible of manual control; and clearance space in proper proportion can be added to both high and low pressure cylinders to meet service conditions. These valves maintain a constant ratio of compression and running balance at all loads. The power requirements are well-nigh directly proportional to the loading. A hand-operated starting valve is provided for each cylinder; and when these valves are open there is no load on the compressor. Closing the valves after starting the machine permits building up the load without causing a disproportional electrical peak.

It has been well said that no elements of a compressor contribute more to its initial and ultimate economy of operation than the intake and the discharge valves, and this is especially true on high-speed compressors, where the action must be quick and positive, and yet allow for the fullest and freest movement of the gaseous medium in entering and in leaving the cylinders. Satisfactory valving is of paramount importance in the ammonia compressors of an ice-plant, where any loss incident to the handling of the gas has a marked effect upon production economies. As explained by an eminent refrigerating engineer, "Suction valves when too small cause what is known as 'wire drawing', which has a tendency to heat the incoming gas; and any type of valve which leads to leakage further increases the temperature of the gas. The net result of this heating brings about a condition analagous to compressing a greater volume of gas, and this raises the average pressure in the cylinder. As a consequence, there is a demand for excess power to run the machine."

After years of research, the makers of the compound compressor already mentioned, have devised a rather remarkable type of plate valve; and it is claimed that this valve is unequalled in the volume of air or gas which it will permit to pass through it, per inch of diameter, at any fixed pressure. For the sake of those who may desire further knowledge about this feature, let us point out that valves of this sort are made of a special steel, heat-treated and tempered; that they are extremely light for a given valve opening—approximately one-third the weight of a poppet valve; that they require considerably less power to open them; and that the lift is very small. A low lift is of marked advantage in any form of valve, as it aids quicker seating and higher speeds, and results in less wear, less noise, and less slippage than would occur if the lift were greater. A valve of this sort is not so likely to break; and the particular design in question has an exceptionally long life.

The operation of the valve is not dependent upon any valve gear or other mechanism. As a consequence, friction is eliminated; and there is a decided gain in simplicity of get-up and in efficiency. The valve is somewhat unique because it does not require exact adjustment, and will function equally well in any position. Finally, inasmuch as there are no rubbing parts, there is no need of lubrication. This disposes of a matter that often occasions much trouble with valves of other patterns.

In the manufacture of ice, the temperature in the brine tank is held at about 12 or 14 degrees Fahrenheit; and the usual freezing period is 48 hours. If the water be frozen more rapidly the ice is apt to become too brittle to handle without considerable loss in dumping it from the cans. The common practice is to employ cans of a size that will average about seven to a ton of ice.

Where it is impracticable to provide an ice storage house to take care of a winter surplus production, Mr. Greene declares that it is feasible to alter the design of a plant so that maximum economies can be attained during the off season while the load is reduced. To quote him: "This can be accomplished by cutting down the size of the freezing tank-room, the tank itself, the coils, and the number of cans per ton, to a point where a machine of the compound type, with twelve cans or less per ton, can realize the same economies in kilowatt consumption as do other plants that are equipped with simple machines and which handle a larger number of cans per ton. This means a smaller initial investment by approximately eight per cent. which naturally reduces the overhead cost during the winter months.

"Further, by running a compound compressor in combination with brine at an especially low temperature, which would ordinarily be abnormal, the maximum production is obtainable from fewer cans. Of course, this does not lessen the kilowatt consumption of the main unit, but, by manufacturing the same quantity of ice in fewer cans, there is a distinct saving in the power needed by auxiliaries, such as the air-agitation equipment, hoists, pumps, etc."

As can be grasped by now, the whole art of ice-making, as well as that of refrigeration generally, is moving forward steadily. This explains why artificial ice is rapidly supplanting natural ice; and why people in some parts of the United States are to-day enjoying a plenty of this refrigerant where little if any could be had a few years ago.

In conclusion, let it be said that our engineering concerns are reaching more and more into foreign markets with their refrigerating and ice-making machinery. During eleven months of 1921, we sent abroad apparatus of this character to the value of $1,691,058. This was greater by $631,154 than our similar exports for the whole of 1913. Our shipments will undoubtedly be larger when the people of other nations learn of the improvements which we have made in this class of equipment.

COAL DUST EXPLOSIONS

Investigations of coal dust explosions by the Bureau of Mines began as far back as 1908, following a series of disasters in 1907. The latest results of these investigations are embodied in a paper (Serial No. 2,306) by Guy B. Taylor and E. C. White. It was generally questioned at the beginning whether coal dust in air is explosive unless "gas" or methane is present. The earliest experiments demonstrated the explosibility of coal dust in itself. Then followed much controversy as to whether the coal dust particles unite directly with the oxygen of the air, or whether gas is instantly distilled from the dust prior to the explosive combustion, the gas so liberated enveloping each particle and propagating the flame from one to another.

The writers of the above paper believe that the results of two entirely independent and radically different investigations show that it is at least possible to inflame coal dust suspended in air under conditions wherein the predistillation of gas appears to be so slight that it cannot be considered an effective factor. A direct attack upon the finely divided dust by oxygen molecules is an alternative explanation. Although in some of the many experiments slight quantities of combustible gas were found after momentary heating, this gas was chiefly carbon monoxide, and no relation could be traced between its relative quantity and the relative inflammability.

AN AERIAL LLOYD'S LIKELY

According to a dispatch from Paris to the New York Times, airships, in the opinion of Laurent Eynac, Under-Secretary of State for Aeronautics, should be rated as other ships are; and this enterprising official is planning a sort of Lloyd's register of airships, which is designed to give the age, the motive power, the date of overhauling, the place of construction, and the port of registry of all passenger airplanes. He says this will afford an absolute guarantee both to air travelers and to aerial-transportation companies. In the language of the Reverend Jasper, "Sholy de sun do move." And those pioneer maritime gamblers of Lloyd's coffee-house are in a fair way now to have their venturesome spirit duplicated in the realm of aeronautics.

San Francisco's Hetch Hetchy Water Supply

PART II*

Details of Some of the Constructional Facilities That Are Helping in the Execution of This Titanic Task

By NELSON A. ECKART and LESLIE W. STOCKER

IN THE PRECEDING article, the authors outlined the general scope and nature of the Hetch Hetchy water-supply system for the City of San Francisco. The present installment will deal with certain preliminary aspects of the vast undertaking and describe some of the facilities which had to be called into being to promote the effective and the expeditious prosecution of the project.

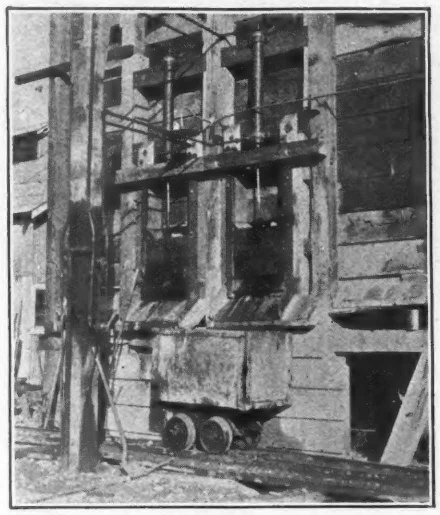
So far all construction work in hand is located in the Sierra Nevada Mountains; and comprises in the main units necessary to the Moccasin Creek power development. The field headquarters of the operations are situated in the little mountain town of Groveland, where the city has erected an office structure, machine shops, car-repair shops, warehouses, a hospital, and dwellings for the employees.

Camps and Housing

On modern construction jobs of any magnitude, a great deal of thought is usually given to the comfortable housing of the workmen and to their proper feeding. This policy is dictated for moral as well as economic reasons, since it tends to reduce labor turnover and to promote the efficiency of the men. The city's camps on the Hetch Hetchy undertaking have all been reared with these principles in mind. Tents are not used except for camps which are to be occupied for only a few months. The buildings generally are substantial, well ventilated, and are provided with electric lights and stoves. Good cooks are employed, and first-class food is served.

Portable bunk houses are erected near the railroad for gangs whose work keeps them but a short time in one locality. At the conclusion of each task the bunk houses are lifted onto flat cars and moved to the next point of operation. Separate cottages are provided at the camps for the men that have their families with them. The camp boarding houses are under the supervision of one steward, whose office is at Groveland. This innovation has brought about a considerable economy in the running of the boarding houses as compared with previous costs when each of these establishments was managed independently. The steward orders all supplies and distributes them from a central warehouse; and this arrangement enables him to buy more cheaply and gives him a check upon the relative consumption at the various camps so that he can detect wasteful or extravagant cooks. All of the boarding houses are equipped with small refrigerating plants, and these are valuable in keeping meats and other perishables from spoiling during hot weather.

*The first installment of the Hetch Hetchy series appeared in the August issue.



Big Creek Shaft, showing storage bin for excavated rock. The discharge gates are operated by compressed air.

Medical Service

The hospital at Groveland was built and outfitted by the municipality for the care of the Hetch Hetchy project employees who might be injured or become ill while in the city's service. The physician in charge and the nurses are all employed by the city. This provision has been found far more satisfactory than the previous one under which a physician contracted with the municipality to furnish the required equipment and service.

Each employee is charged a hospital fee of one dollar per month to cover the expense of medical attention in case of sickness or injury not resulting from his occupation. In addition, the city receives a reduction on its workmen's compensation insurance premiums because its hospital service relieves the State Compensation Insurance Fund of disbursements for similar facilities. These two sources of income suffice to make the medical service self-supporting.

New men are examined physically before being employed to guard against burdening the medical organization with the care of persons already defective or undesirable in one way or another.

Central Warehouses

Warehouses have been established at Groveland, where large stocks of tools, spare parts for machinery, supplies of all kinds, provisions for the boarding houses, etc., are kept on hand and issued as needed. The stock of spare parts for drills is probably larger than that of the factory branches, in San Francisco, of the manufacturers of these tools. This system permits purchasing in large quantities; keeps track of the stock available; and minimizes the delay incident to securing parts. It also facilitates cost accounting.

Shops

The rolling stock of the Hetch Hetchy Railroad and the construction outfit at the various camps represent an investment of approximately a million dollars. Prompt attention to all maintenance and repair work is necessary so as keep within reasonable limits the amount of equipment temporarily out of service. To this end, well-appointed shops were called into being at Groveland. Besides a compressed air plant, a comprehensive group of motor-driven machine tools, and other apparatus, there are such lesser items as forges, blowers, pneumatic hand tools, etc. The car-repair shops are provided with wood-working machinery, such as band saws, circular saws, planers, etc. The total cost of the shop equipment has amounted to more than $25,000.

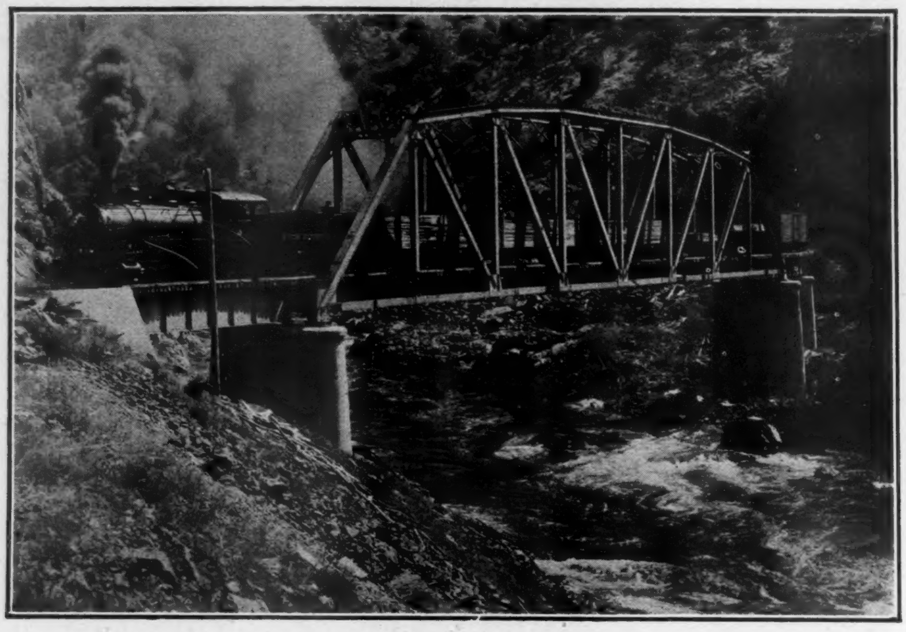
These shops do substantially all repairing and overhauling of the Hetch Hetchy Railroad rolling stock and similarly deal with the tunnel construction machinery whenever the jobs are beyond the capacity of the small shops at the various camps. Before these conveniences were available, any locomotive requiring extensive repairs had to be sent to the Southern Pacific Railroad shops at Sacramento. There is no need of this now except for boiler plate work.

The Hetch Hetchy Railroad

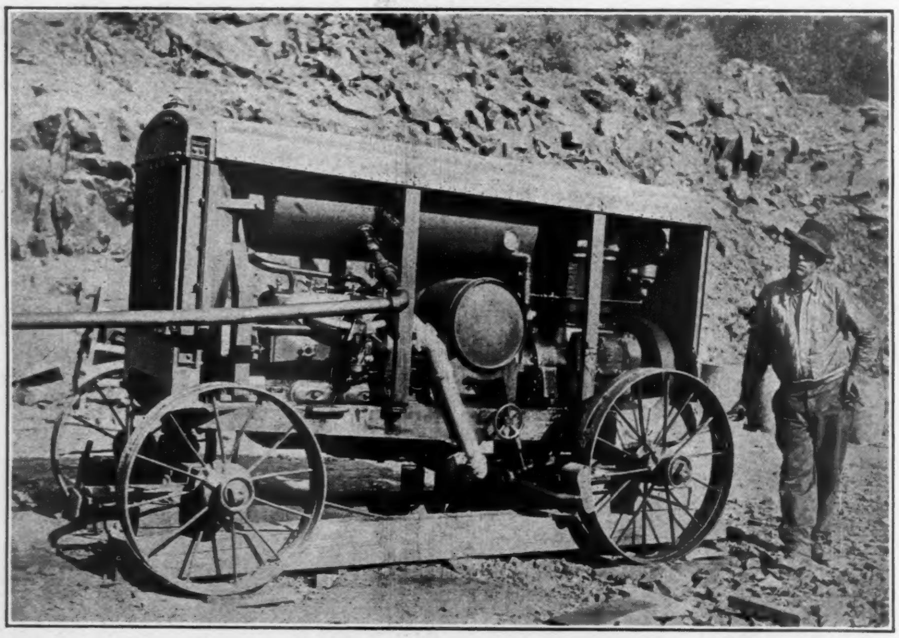
Before work could be commenced on the construction program already outlined, transportation facilities had to be provided. The nearest railroad was 55 miles from Hetch Hetchy, by rough mountain roads and trails impassable in winter. It was realized that 300,000 tons of cement and other structural materials would have to be transported for use in building the dam and the aqueduct. Motor-truck haulage meant an outlay of 50 to 60 cents per ton-mile. To solve this problem, the Hetch Hetchy Railroad was built by the city.

The new line connects at Hetch Hetchy Junction with the Sierra Railway, and extends 68 miles easterly to the site of the Hetch Hetchy dam. As the crow flies, the distance between the two terminals is 40 miles. The road is of standard gage; of permanent construction throughout; uses 60-pound rails; has a maximum curvature of 30 degrees; and a maximum grade of four per cent. compensated for curvature.

At the dam site, freight is delivered directly to the job. Stations are located close to the working points along the aqueduct line, thereby facilitating delivery on spur tracks by tramways or by motor trucks.



A train on the Hetch Hetchy Railroad crossing the Tuolumne River. This steel bridge has a span of 220 feet.



Ingersoll-Rand, gasoline-engine-driven, portable compressor of the wagon type such as is being used on parts of the Hetch Hetchy project to supply operative air to pneumatic tools working in remote and somewhat inaccessible places.

Blacksmith shop at Big Creek Shaft equipped with Leyner sharpeners. The drill car in the picture is used to carry drills between the shop and the heading by way of the shaft.

This railroad, exclusive of equipment, involved an expenditure of over $2,000,000. It is being operated as a common carrier, and thus aids in developing the forest country through which it passes by giving reliable and relatively cheap freight service. The region is attractive to tourists owing to the wild and rugged scenery, and also because of its historical interest. It is a section of the famous "Mother Lode" gold-mining district, and an area made familiar by Bret Harte, Mark Twain, and other writers of California's pioneer days. The income from hauling done for outside parties is a substantial one, and helps to reduce the cost of the whole project to the taxpayers. The charge against the city for this transportation is small, as practically all of the carriage is westbound and in trains which otherwise would return unloaded to Hetch Hetchy Junction.

The rolling stock of the railroad consists of six locomotives, two passenger coaches, 3[?] freight cars, three cabooses, 27 air dump-cars, one big steam shovel, one tank car, one wrecker, five gasoline motor cars for passenger service, and four gasoline motor cars for handling freight.

Prior to purchasing the first locomotive for the road, the question was thoroughly discussed as to whether it would be wiser to buy direct-connected or geared engines. The consensus of opinion of men experienced in operating railways having similar maximum curvatures and grades was found to favor geared locomotives, and at the start tractors of this type were obtained. Later, rod or direct-connected engines were secured. Both kinds have now been tried out for several years on the job, and the superiority of either for the special conditions to be met is still an open question. Each type has inherent features that make it fit for particular classes of service; and the requirements vary greatly not only on different roads but on different parts of the same road.

The light-rod engine of 64 tons weight is, within its capacity, notably satisfactory. It has good operating speed, is easy on the track, and is low in cost of maintenance, but its capacity is too limited when the amount of freight to be handled is relatively large. As between the bigger rod and the geared engines of approximately the same tonnage capacity, the rod engines are faster and their upkeep is lower; but the gain in lower engine maintenance is more than offset by higher track outlays due to the effects of the longer, rigid wheel base. In the rainy season, with a soft road-bed, it becomes necessary to depend on the geared and the light-rod engines, as the track cannot be kept in proper condition at that time to safely carry the 95-ton rod engine.

The Hetch Hetchy line represents a much heavier investment than is usual with railroads built in connection with construction projects. This was considered justified in view of the more reliable service assured throughout the year by a substantially-constructed and well-equipped railroad, and also because of the prospective industrial developments of a permanent character, such as sawmills and mines,

An interior view of the Early Intake power plant. There are three 1,000-KVA. generators driven by 1,500-horse-power turbines.

which will utilize the greater part of the mileage after the city's work is completed.

Sawmill

While the railroad was under construction, a sawmill was established a few miles from Hetch Hetchy to manufacture lumber for forms, tunnel timbering, flumes, railroad ties, buildings, etc.

The mill has a capacity of from 25,000 to 30,000 board feet per eight-hour shift, and has cut over 13,000,000 board feet.

Logging operations are assisted by donkey engines and cables—the latter covering a radius of nearly a mile. The mill equipment is ample to meet all needs; and the plant is operated by steam. This form of drive was chosen so that slabs and refuse lumber could be used to fire the boilers. Some slab wood is shipped to a few of the construction camps for fuel.

The Lower Cherry Power System

The third unit of a preliminary character was a complete hydro-electric system built to provide power for construction machinery.

The plant is located near the head of the aqueduct, at Early Intake. This point, as it happens, is close to the load center of the work on the dam and the aqueduct.

Water is diverted from the Cherry River into a conduit of 200 second-feet capacity, consisting of one mile of concrete-lined canal, 1½ miles of flumes, and five tunnels aggregating one mile.

The tunnels, which pierce a granite formation, are unlined except at the portals and at a few places where loose rock was encountered. They are 7 ft. 6 in. in height and width.

In excavating the tunnels, two portable compressor outfits, with gasoline-engine drive, were used. The air was piped a maximum distance of about a mile. Two drills were employed in each heading. The muck was removed in end dump cars hauled by mules. This work was done by MacArthur Brothers, at an average contract price of $12.20 per linear foot of tunnel.

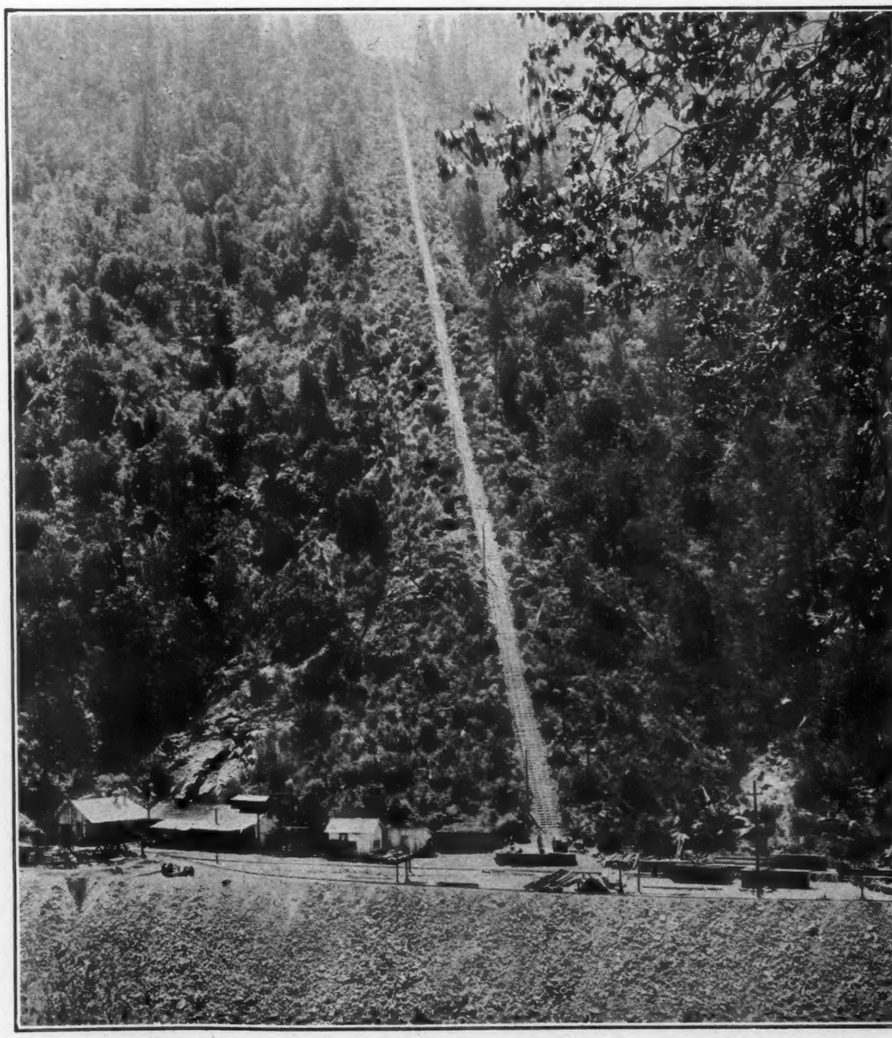
To save time and to keep down initial outlays, wooden flumes were run along the slopes of some very steep hillsides. In the future, tunnels and reinforced concrete flumes will be substituted so that the conduit will be of a permanent nature throughout. It is the intention to extend the conduit eventually in order that it may discharge into the Tuolumne River above the Early Intake diversion dam, and thus make it tributary to the main Hetch Hetchy aqueduct.

The standard flume is 7 ft. 6 in. wide and 4 ft. 10 in. deep, built of pine, with cedar sills where it is on bench and with concrete footings where it is supported on trestle. In its construction, short sections were completed up to the floor level and the floor was laid. A wooden rail track was then placed on the floor, and push cars were used to convey lumber for the sides and caps of the section already partly finished, and for the foundation and floors of the next section to be built. In all 1,300,000 board feet of lumber was worked into the flumes.

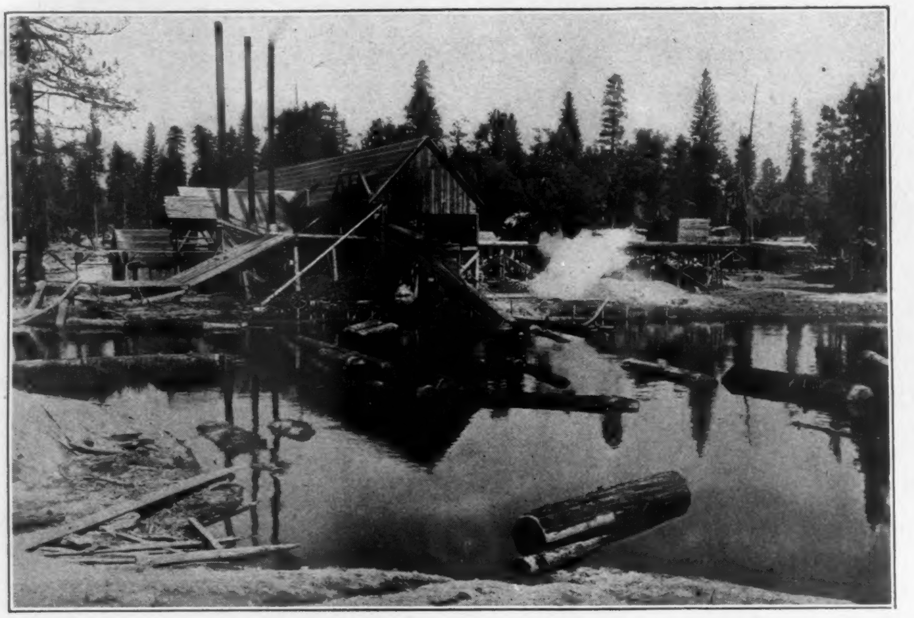
A small forebay, with a storage capacity of about four acre-feet, was provided to take care of minor fluctuations of load. This was done by building the last 2,000 feet of flume of larger cross-section—9 ft. wide and 9 ft. 9 in. deep. The 35-degree slope of the hillside precluded any other form of forebay reservoir above the power plant.

The riveted steel pressure pipe from the forebay to the power plant is 42 inches in diameter, $^{3}/_{16}$ to ⅜-in. in thickness, and 530 feet long. At the bottom it branches into three 28-inch connections, one for each turbine.

The power house is a frame building, with walls and roof of corrugated asbestos-protected metal; and heavy concrete foundations are provided for the machinery. A rip-



The tramway at Early Intake. This line extends from the Hetch Hetchy Railroad down to the tunnel portal, has a length of 3,800 feet and a drop of 1,500 feet with a maximum grade of about 80 per cent. The tunnel portal is beneath the bare patch of rock to the left of the tramway.



The sawmill at Mather, which has a daily capacity of 25,000 board feet. The pond was formed artificially.

rap wall, built out into the river bed, forms a tail-bay of quiet water and keeps drift away from the tailraces.

The three water-wheels are Pelton-Francis turbines, with horizontal shafts, each designed to operate at 720 r.p.m., and to develop 1,500 horse-power under a maximum head of 345.5 feet, including a draft head of fifteen feet. The guaranteed efficiency at full load is 80%; at 3/5 load 79½%; and at half load 76%.

The generators are direct-connected to the turbines. They are 2,300 volt, 3-phase, 60-cycle, General Electric machines, each of 1,000 KVA. rated capacity, with direct-connected exciters, and guaranteed to give efficiencies of 96% at full load, 95.6% at ¾ load, and 94.4% at half-load. A motor-generator set is used as a spare exciter unit.

The transformers are of the Westinghouse single-phase, oil-insulated, water-cooled, outdoor type, rated at 1,000 KVA. each. They are four in number, one being a spare. They step up from 2,300 to 23,000 volts.

Two transmission lines distribute the current to the construction sites. One line extends 14.5 miles east to the Hetch Hetchy dam, and the other runs nineteen miles west along the main aqueduct to Priest, with a two-mile branch to Groveland. The right of way was cleared of timber for a width of 100 feet, and dead trees outside of the 100-foot strip, which if left standing might fall onto the line, were removed. The poles are of local cedar, normally spaced 225 feet apart. Each line consists of a single circuit of three No. 4 copper wires. There are several spans of ⅜-in. stranded steel cables which cross deep ravines—the longest being 2,200 feet.

The sub-stations are all of the outdoor ty The low tension voltages are 440 and 220 vol for operating motors, and 110 volts for ligh ing. At Hetch Hetchy there are three sub-st tions totaling 2,185 KVA. capacity. The su stations along the aqueduct line, which furni power for tunnel construction, range in capa ity from 150 KVA. at Early Intake, whe only one heading is served and very lit pumping is required, to 600 KVA. at Big Cre shaft, where the work is 575 feet below grou and progressing in both directions, and to 7 KVA. at Second Garrotte shaft, where a larg quantity of water (up to 2,000 gallons per mi ute) is pumped. A 75-KVA. sub-station Groveland furnishes power to operate the m tors in the shops and to light the city's buil ings. The total sub-station capacity linke with the system is 5,260 KVA.

The hydro-electric plant is being operated all times as near full capacity as practicabl and the power generated in excess of constru tion requirements has been sold to the Paci Gas & Electric Company and is delivered that system through a connection at the we end of the city's transmission line. The r sulting revenue, up to the present, totals ov $225,000. This income will decrease hereaft as the city's use of the current for constructi purposes increases.

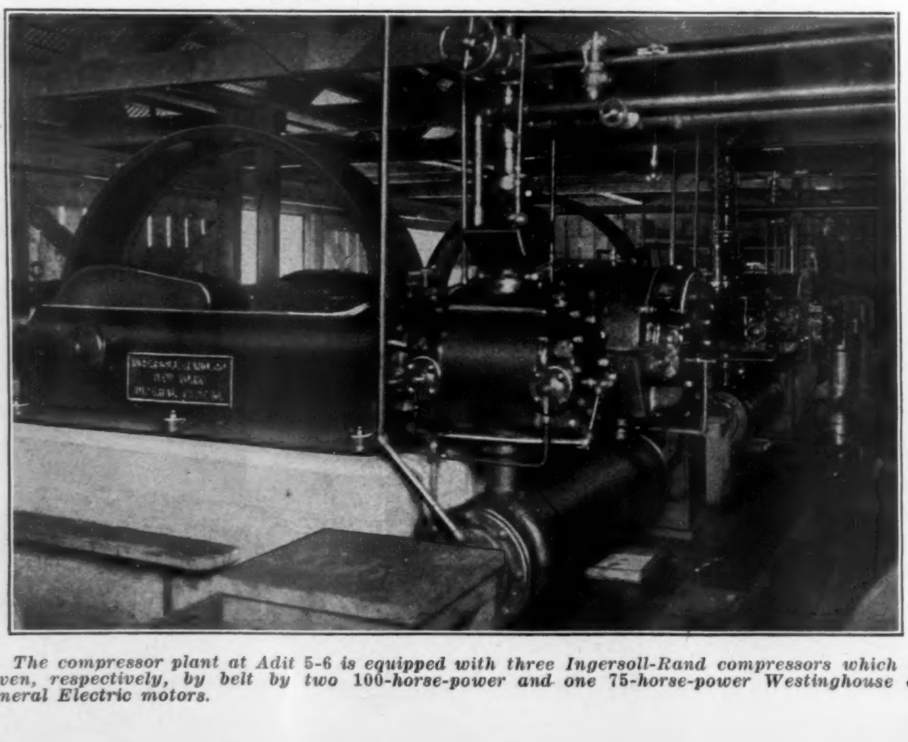
The probable operating conditions of t plant, as indicated by the specifications, r quired that "each generator shall be rated as 1,000-KVA. unit and shall be capable of carr ing a continuous load of 800 KW. at rat voltage and 80 per cent. power factor." Ho ever, when furnishing energy to the Paci Gas & Electric Company, the power factor maintained very close to unity—seldom falli as low as 95 per cent. and it has been fou practicable for the generating units and tran formers to carry a continuous load ten p cent. above their rated capacity. Therefore, i stead of the 800 KW. originally expected fro each machine, no trouble is experienced maintaining a continuous load of 1,100 KW. o each generator in service. The 80-per ce power factor assumed in designing the plant not realized when the station is meeting th needs only of the construction work, i. e., wi the commercial line disconnected. In that cas the power factor drops to 70 per cent.

(To be Continued)

TO IMPROVE CHINA'S GRAND CANAL

The Grand Canal of China is the longe artificial waterway in existence, as also pe haps the most ancient. Its length is 1,10 miles and in its course it crosses three grea rivers. The canal is of immense pote tial and considerable actual importance t four rich provinces of the Chinese Republic although it has been allowed to deteriorate i efficiency and capacity. The problem of restor ation and improvement has been studied b American engineers, and extensive operation are planned for the near future.

The wood-working and the lumber industrie of the United States employ an army of near ly 1,000,000 men, and these activities represen a capital investment of fully $12,000,000.



The compressor plant at Adit 5-6 is equipped with three Ingersoll-Rand compressors which are driven, respectively, by belt by two 100-horse-power and one 75-horse-power Westinghouse and General Electric motors.

High-Pressure-Gas-Distribution System of the Western United Gas & Electric Co.

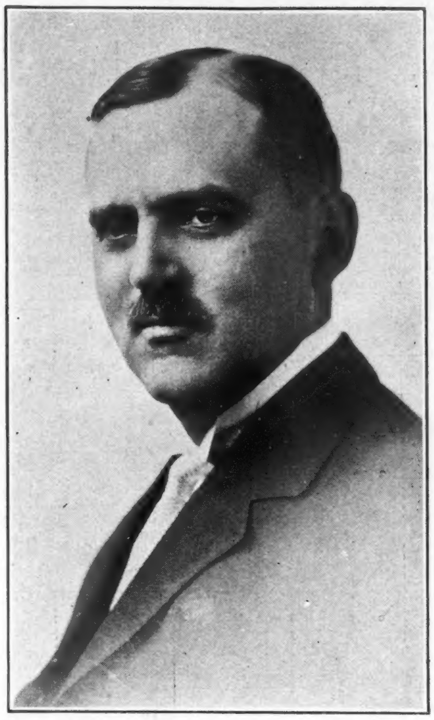
The Introduction of the High-Pressure System Has Radically Altered for the Better the Economics of Gas Generation and Distribution

By C. W. MELCHER

DATING FROM the 1861 charter of the Aurora (Illinois) Gas Light Company and from the first delivery of commercial gas to consumers on December 22, 1868, the half century following the initiation of this modest service has shown a marvelous growth and development in the manufacture and in the distribution of gas to the small cities and the suburban towns tributary to Chicago.

At that early period, under the usual system of distribution from storage holders at a pressure of only a few ounces, each city or village required an independent gas plant—a condition which was radically changed by the introduction of the high-pressure system of distribution. As early as 1875, beginning in England and following in this country, pumping had been resorted to at low pressures so that more gas might be delivered through established mains. The initial pressure used being about a pound or two; but this was gradually increased to ten pounds with the installation, in 1885, of what was probably the first intentional high-pressure line, one running from Oakland, Calif., to Alameda, a distance of 8,300 ft., under an arm of San Francisco Bay.

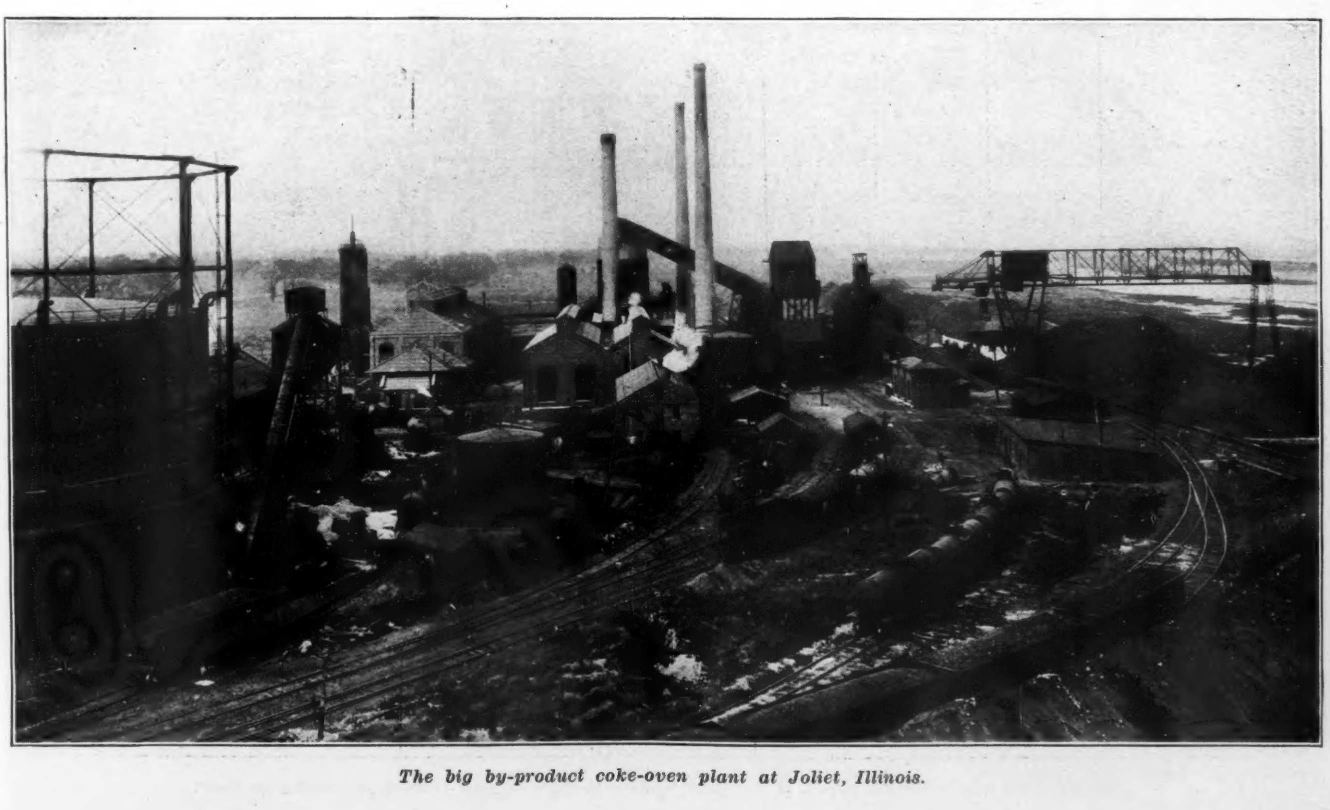
The feasibility of pumping gas long distances through high-pressure mains made desirable and possible the merger and consolidation of many isolated gas plants in the larger towns, and permitted service to the smaller intermediate places direct from the high-pressure connecting mains.



Ira C. Copley

Mr. Ira C. Copley, who owned the Aurora Works, early saw the value of high-pressure distribution, and planned to try it out on a commercial scale. Accordingly, in 1902, after securing franchises from three small towns, Geneva, Batavia, and St. Charles, extending twelve miles north of Aurora along the Fox River, he installed a four-inch pipe line connecting these towns with the Aurora plant. This was so successful that a larger field of operation was made practicable; and three years later, in 1905, a merger was consummated under the name of the Western United Gas & Electric Company, which brought within a single organization the Aurora, Elgin, La Grange, and Joliet plants and made necessary a re-planning of the entire gas manufacturing and distributing system so as to insure the highest efficiency and economy in the consolidated territory.

As president of the new company, Mr. Copley first undertook an exhaustive investigation abroad and, accompanied by competent engineers, he traveled several times through England, Austria, and Germany, where he inspected some of the largest and most efficient gas plants in the world. The knowledge gained on these trips led to the adoption of the Koppers by-product coke-oven system, and the new plant, the first of its kind in America, was built on the Chicago Sanitary District Canal, near Joliet, Illinois. From the standpoint of distribution, this was not at all



The big by-product coke-oven plant at Joliet, Illinois.

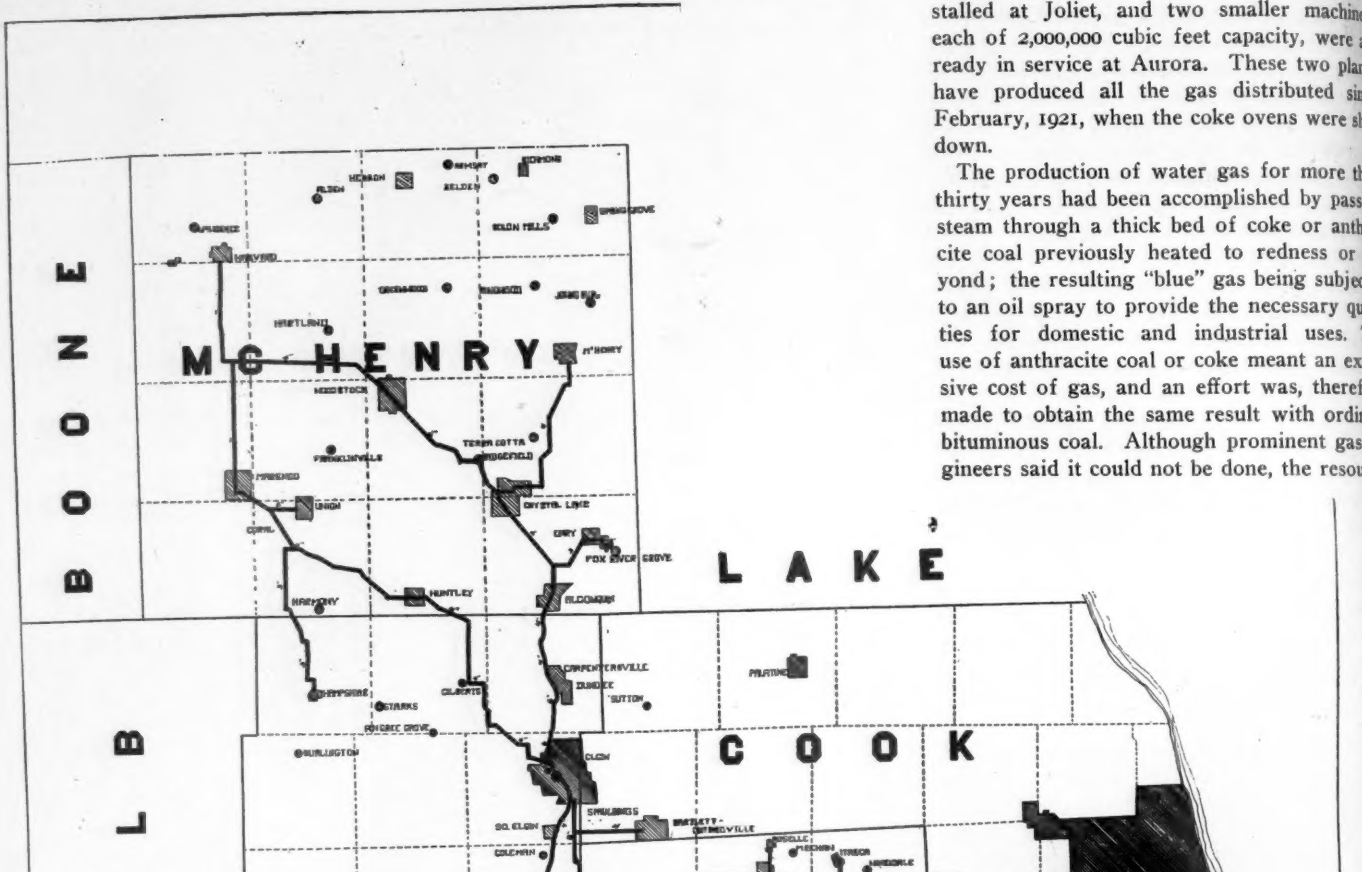
a central location, but the low cost of coal transportation was such an item in economical gas production that the Chicago rate available at this point was the deciding factor.

The Joliet by-product coke-oven plant, which was completed and ready for operation in 1912, consists of 53 coke ovens having a combined daily capacity of 945 tons of coal and capable of producing each day 5,670,000 cubic feet of gas, or 2,000,000,000 cubic feet per year, and by-products amounting annually to

241,500 tons of coke.
2,415,000 gallons of tar.
3,450 tons of sulphate of ammonia.

Although the by-product coke oven is the most effective gas-making agency known, and extensive coal properties in Southern Illinois and West Virginia had been acquired by the company in order to be in control of the necessary fuel, high running costs and no coke market after the war forced the erection of a water-gas plant producing gas from oil and coke. Five large water-gas machines, each of a daily capacity of 3,500,000 cubic feet, with auxiliary equipment and holders, were installed at Joliet, and two smaller machines, each of 2,000,000 cubic feet capacity, were already in service at Aurora. These two plants have produced all the gas distributed since February, 1921, when the coke ovens were shut down.

The production of water gas for more than thirty years had been accomplished by passing steam through a thick bed of coke or anthracite coal previously heated to redness or beyond; the resulting "blue" gas being subjected to an oil spray to provide the necessary qualities for domestic and industrial uses. The use of anthracite coal or coke meant an excessive cost of gas, and an effort was, therefore, made to obtain the same result with ordinary bituminous coal. Although prominent gas engineers said it could not be done, the resource-



Northern Illinois territory which is supplied, as indicated, with gas by high-pressure pipe lines.

fulness of the Western United engineers found another way. To-day not a pound of coke is being used, but, instead, the bituminous coal from the company's mines serves every purpose; and even though the capacity of the machines is much reduced the same quality of water gas is now made at a much lower cost. Having both coal and water-gas equipment, the Western United Company's gas-producing plant is without an equal in flexibility; and no matter how the costs of labor and materials may fluctuate, it is always in a position to meet any emergency.

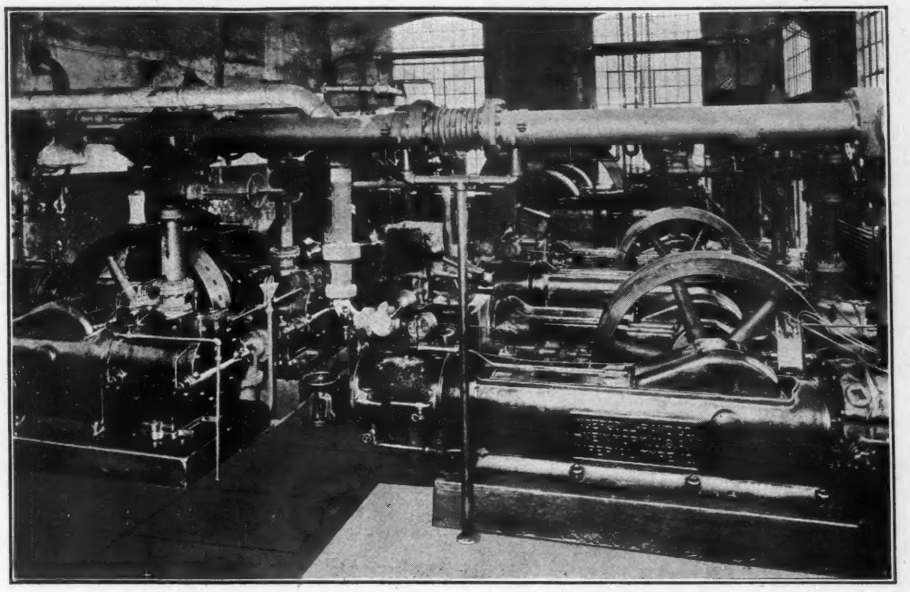
The high-pressure pipe-line system is shown in detail on the accompanying map. It starts at the Joliet plant with two eight-inch, steel pipe lines and conveys gas to Aurora and Elgin, and intermediate towns, as well as to the suburban towns along the Burlington Railroad eastward to Brookfield, and on the Northwestern Railroad east to Elmhurst, and to the north as far as Harvard, 85 miles from the point of production. Altogether, gas is served to 63 towns, with a total population of 240,000, outside of Chicago but within 50 miles of that city's limits.

There are 305 miles of high-pressure pipe lines, varying in size from four to eight inches —depending upon service requirements, and 348 miles of high-pressure mains, mostly one-and-a-half-inch pipe, supplying high-pressure gas directly to the consumers.

In connecting with the high-pressure pipe lines, towns like Aurora, Elgin, and La Grange already using a low-pressure system, were directly served by existing holders and district governors, which reduced the pressure to the usual holder pressure. The earlier towns, when gas was first installed, followed the same plan of low-pressure service mains supplied through a district governor from the high-pressure line, necessitating the installation of large mains and service pipes; but, with the development of an inexpensive and safe governor for the use of individual consumers, all so-called high-pressure towns are now piped with comparatively small mains—mostly one-and-a-half-inch, with three-quarter-inch service and an individual governor in each house. This practice is followed in all towns along the Northwestern Railroad and those north of Elgin. This type of house governor can safely handle a maximum pressure of 35 pounds, and when, of necessity, the high-pressure pipe line to that point carries over that pressure, a reducing governor is installed at the inlet of the high-pressure towns. In this way the town pressure can be held as low as five pounds, while allowing the trunk line to build up pressure as high as needful to deliver gas into the holder at the end of the system.

In order to distribute gas to the most distant service points at a pressure of five pounds, which is the pressure in the high-pressure pipe line at La Grange and Elgin, it is necessary to start out from the Joliet plant with a maximum pressure of 70 pounds, so that the gas arrives at Aurora at a pressure of ten pounds, and at intermediate points, such as Wheaton, Downers Grove, and West Chicago, at a pressure of 35 pounds.

The pressures are maintained with reason-



Four 16-inch stroke, Type "X" and one 30-inch stroke, Type "XPV," steam-driven compressors installed at the Joliet plant.

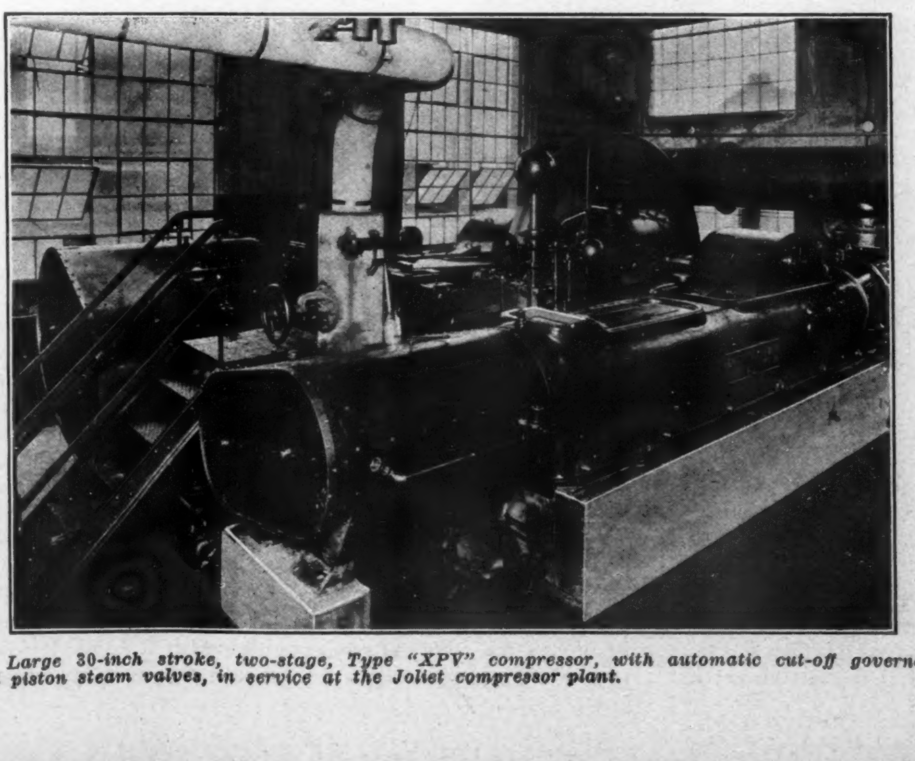
able uniformity by manual control, leading the surplus gas into storage holders at Aurora, Elgin, and La Grange, from which it is re-pumped into the mains during peak-load periods.

Under normal requirements, gas from the Joliet plant passes directly to Sandwich, southwest of Aurora; but when the peak load is reached, the valve in the pipe line is closed and the gas is first drawn into the Aurora holder from the incoming high-pressure main and then re-pumped to Sandwich and intermediate towns beyond Aurora.

On the first high-pressure pipe lines installed in 1902, steel black pipe with screwed joints was employed, and this has given good service as evidenced by all the original lines still in use. Steel black pipe is still employed, but, instead of screwed joints, the ends of the pipes are butt-welded by the oxy-acetylene process. On the early lines it was the practice to use expansion sleeves every 500 feet, but this is no longer considered necessary.

To test all pipe lines, the joints are coated with soapsuds and a high pressure gas is turned into the line. To insure an absolutely tight line, two tests are made: one before the main is lowered into the ditch and a final one with the pipes on the bottom, just before filling in the trench.

To distribute the present 24-hour consumption of 6,000,000 cubic feet of gas—which, by the way, is effected at an outlay of not more than four cents per 1,000 cubic feet, four gas-compressor pumping stations have been called into being. The main compressor plant at Joliet, which handles the entire 6,000,000 feet and delivers the gas to the mains at a pressure of 70 pounds, is equipped with four 16-inch stroke, Type "X", and one 30-inch stroke, Type "XPV", Ingersoll-Rand steam-driven compressors.



Large 30-inch stroke, two-stage, Type "XPV" compressor, with automatic cut-off governor and piston steam valves, in service at the Joliet compressor plant.

The three re-pumping compressor plants—located, respectively, at Aurora, Elgin, and La Grange—for distributing the gas to the holders to take care of the peak-load periods, are also equipped with the same make of compressors but of different sizes and capacities agreeably to the district requirements. In most cases, the machines are steam driven because of the extreme adaptability of that kind of prime mover in meeting varying loads. In a few instances, however, electric-motor drive has been found desirable.

The average analysis of gas made at Joliet is as follows:

	Water Gas.	*Coal Gas.*
CO_2	5 per cent.	2½ per cent.
Illuminants...	11 "	3½ "
Oxygen	½ "	.2 "
CO	35 "	7½ "
CH_4	15 "	31 "
Hydrogen ...	28 "	46 "
Nitrogen	5½ "	9.3 "

In compressing to 70 pounds and transmitting twenty miles, there is a loss of about 35 heat units for the water gas and twenty heat units in the case of the coal gas of the above analysis. This loss is due to the dropping out of the unfixed vapors in the gas, consisting of benzol, toluol, and similar hydrocarbons generally classed as illuminants, the larger percentage of which in water gas accounts for the greater drop in heat units.

For distribution at five pounds pressure or higher, gas of 530 B.T.U. was made standard in 1914 by the Illinois Public Utility Commission; and the tendency is towards a gas of about 500 B.T.U. which can be most economically made with the present type of plant and transmitted long distances with small loss in heating value.

The gas distributed through the mains of the Western United Gas & Electric Company is produced by the Coal Products Manufacturing Company. In Southern Illinois, the Southern Illinois Gas Company, representing the merger of numerous smaller companies, serves another district, and operate coal mines both in Illinois and West Virginia. Gas is but one of the several commodities supplied by this corporation, inasmuch as steam heat, electricity, and water are delivered in certain localities as well. All of these varied industries are associated under the name of the Western United Corporation.

From 1889, when he was first associated with the Aurora Gas Light Company as its general manager, Mr. Ira C. Copley, now the president of the Western United Corporation, has been personally responsible for the development of this magnificent system, which was conceived, organized, and completed under his personal management.

The author wishes to acknowledge that in the preparation of this article much assistance was given him by Mr. C. C. Boardman, the assistant general manager of the Western United Gas & Electric Company.

Customs receipts for the fiscal year just ended were nearly $23,000,000 greater than those of the largest previous twelvemonth in the history of the customs service.

DRILL STEEL—BITS AND SHANKS

[Drill steel has always been a much discussed subject and it probably will continue to be as long as there is rock to drill and blast. We are continually receiving letters asking for advice on various phases of this subject. Most of these questions and their answers are of interest to a large part of our readers, and therefore this column is published in order to give our readers the benefit of the service that we have been rendering through this correspondence. Questions are especially invited which have to do with any phase of forging, tempering and the care of drill bits and shanks. Our answers, based on the best modern practice, will be published in succeeding issues.—ED.]

Compressed Air Magazine,
New York City.

Dear Sir:—In order to settle an argument we have had about drill steel, will you please tell us what is the meaning of burnt steel and does this mean the same thing as over-heated steel.

I say that it does not because I know that you can heat steel to different temperatures, some of them very high, and the steel is not burnt on the surface. H. G. T.

Duluth, Minn.

Overheated steel is steel that has been heated beyond the proper forging temperature, but not the burning stage. The higher the heat the coarser the grain structure. Burnt steel occurs when the steel is heated until oxidation takes place along the crystal boundaries, which results in destroying the full cohesion between the crystals. Burnt steel cannot be tempered as the carbon properties have been destroyed and it is therefore ruined. Overheated steel is ordinarily damaged but not necessarily ruined.

Compressed Air Magazine,
New York City.

DEAR SIR:—I have been told that a magnet can be employed with good results in tempering drill bits. I should be glad for any advice you can give me on this subject.

Yours truly,

Butte, Montana. S. R.

This is a question on which there is a variance of opinion. It is claimed by some men who are well versed in tempering drill steel that to obtain good results it is necessary to heat the steel well above the decalescence point (the point at which it loses its magnetism), which is somewhere around 1,370 degrees Fahrenheit, for a good grade of commercial steel. It is recommended that the temperature of the steel should be raised to 1,450 degrees Fahrenheit. The bit should then be immediately plunged in brine for a distance of about ¾ in. back of its cutting. In other words, the bit is to be plunged on a rising heat.

Others claim that the bit should be plunged on a falling heat, and that the proper temperature to submerge the steel is at its recalescence point or at the instant it regains its magnetism. In each case it is claimed the bit is properly hardened for almost any rock condition. There have been devices made for carrying out each of the foregoing ideas.

We feel that this question is open to discussion, and we should be glad to hear what experience our subscribers have had.

Compressed Air Magazine,
New York City.

DEAR SIR:—I bought a sinker some time ago to drill in some rather soft rock. The drill I'm sure is running all right, but I'm having trouble with plugged bits. I don't seem to be able to prevent this. I use four-point bits on ⅞-in. hollow hex. steel.

Yours very truly,

Dallas, Texas. W. S.

We cannot very well answer your question intelligently without knowing more about the nature of the ground. However, the source of the trouble may be on the shank end of the steel. Do you keep the hole in the shank open? With continued usage of "Jackhamer" shanks, there is a tendency for the hole to pein over and close, for this end is subjected to many thousand blows of the piston in a day's run. With a pressure of 70 pounds, and with the drill and shanks in good condition, if you find the difficulty still exists, we suggest then that you punch two holes in the bit about 1½ in. back of the cutting edge on diametrically opposite sides. This should eliminate the plugging. Be careful in punching these holes that they are put in at an angle of about 45 degrees to the axis of the steel, and exercise care that in doing so you do not close the hole in the center of the steel.

In case the steel still buries itself and the cuttings cannot be blown out, your ground may be of such a character that some form of twisted steel should be used.

Compressed Air Magazine,
New York City.

SIRS:—I am a blacksmith for ten years, and I got a job now where I've got to sharpen steels for four "Jackhamers", and it keeps me and my helper busy. My boss complains about my bits chipping off on outside end. I'm heating them in a coal forge just as I have always done, and for tempering I'm plunging them in water. Never had this trouble before. I would thank you to help me.

Yours truly,

Reading, Pa. J. F.

We are assuming that you are doing this work by hand. You say you have never had this trouble before and that you are following the same methods in heating and tempering as on other jobs. You furthermore state that you are kept busy. Possibly you have more steels to sharpen in a day than you can properly take care of, and it may be that in order to keep up with the drills you are forcing your coal forge. By doing so, you may be heating your steels too fast which, when you temper them, will develop cracks with the results such as you describe. An oil furnace of sufficient capacity would correct this condition, and you would also find a sharpener a big help to you.

Reducing the Labor Item in Laying Gas Pipe

An Extensive Application of Pneumatic Tools, Operated from Portable Air Compressors, Lowers Cost in Laying a Six-mile Gas Main

By ROBERT A. LUNDELL

THE EXTENSION of a gas pipe-line in the suburbs of New York City, involving the laying of approximately six and one-half miles of new pipe, has demonstrated numerous ways in which pneumatic tools can be utilized in quickening the work and in reducing the labor item.

This connecting gas pipe-line is being run from a point in the eastern portion of South Yonkers, N. Y., down to a gas holder at Kingsbridge Road, New York City.

The new pipe-line, of 20-inch diameter, is being laid at a depth of approximately three feet from surface and makes necessary the excavation of a trench four feet wide and five feet deep through ground of varying character. Almost every kind of ground is found along the line in the trench work—such as clay, solid rock, and sand, as well as clay with many large boulders interspersed. Of the total distance, 37 per cent. was figured as rock, with mostly clay and boulders for the remainder.

The plans for the work stipulated a time limit of five months for the completion of the project. Started the first of April in Yonkers, the beginning of September should find the pipe-line completed to Kingsbridge Road. This meant that the following working schedule had to be maintained: 275 feet of trench excavated daily; one 12-foot pipe length placed every fifteen minutes; and one pipe joint calked for every corresponding time interval. With the pipe laid and calked, the trench had then to be filled and tamped at a similar rate so that the completed work could move forward an average of at least 275 feet each eight-hour day.

The joints were all calked with lead wool by pneumatic hammers at one-half the cost of hand calking.

As the pipe-line route lay along many busy streets and thoroughfares, it was necessary to avoid tying up traffic as much as possible and to open up the trench, put down the pipe, calk and backfill in the shortest space of time. To accomplish this it was felt that a relatively small and compact working unit would be more satisfactory than a large force spread over many feet of trench.

Confronted with the problem of carrying on the work according to the program outlined, and of holding down costs, modern machines and methods were needed to replace hand labor wherever possible.

The high percentage of rock excavation required, of course, the installation of air compressors and rock drilling equipment for that phase of the work. Experience had proved that calking pipe joints with lead wool meant the employment of pneumatic hammers to insure speedy and satisfactory progress, for it was well known that pneumatic calking is much superior to hand calking for gas-pipe work in the streets of New York City—many of the companies doing all the calking of lead-wool joints by pneumatic hammers. With compressed air on the job for such operations, why not apply this convenient power medium to other work to equal advantage? With this idea in mind it was determined to use air tools wherever such procedure seemed at all feasible.

Working in coöperation with engineers from the Ingersoll-Rand Company in selecting equipment, methods were then devised which enabled the work to be carried on in a remarkably efficient manner.

The various operations on which it was deemed advisable to use air power, and the machines employed in each case, were as follows:

Breaking the paving or hard top-surface for the trench—pneumatic paving breakers.
Rock Excavation—"Jackhamer" drills; used also for breaking up boulders.
Clay and Hard Sand Excavation—Pneumatic picks for loosening the material.
Pipe Calking—Pneumatic hammers.
Backfill Ramming—Pneumatic hand rammers.

As the ground along the way of the trench varied, no one excavation method was adaptable to all conditions, but operations had to be changed frequently to suit the character of the ground at each point.

THE ORGANIZATION.

Engineer in charge.
General foreman.
3 Excavating foremen.
1 Rock foreman.
1 Pipe laying foreman.
1 Pipe calking foreman.
1 Backfilling Foreman.
Total 175 to 180 men employed.

PNEUMATIC EQUIPMENT.

Paving breakers.
"Jackhamer" drills.
Pneumatic picks.
Calking hammers.
Backfill rammers.
Four 118-cubic-foot, portable, gasoline-driven compressors and two 210-cubic-foot portable gasoline-driven compressors, having a combined total air capacity of 890 cubic feet per minute.

The selection of the portable compressor units in preference to heavy machines of larger capacity was made because of the following considerations:

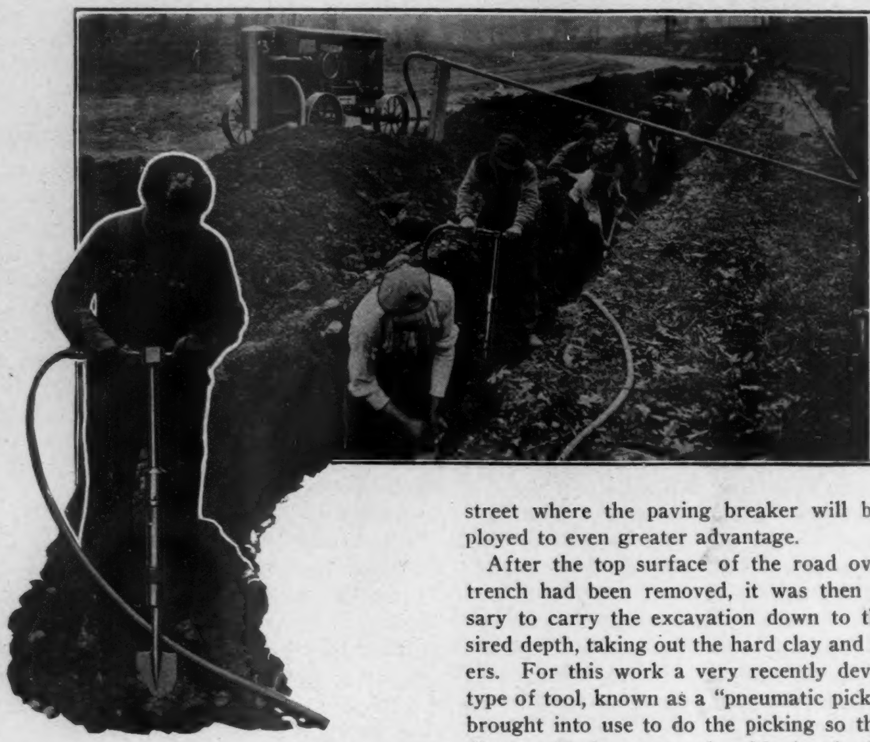
1st. The small units could be obtained from stock, which made immediate delivery possible.

2nd. These could be used separately later on for other jobs on which a few air tools would be employed.

3rd. The ease of moving the units from one position to another.

4th. With the small machines, blocking, foundations, housings, etc., were not needed.

Two "Little David" calking hammers of 2-inch stroke size, calking lead wool in gas pipe joint.



Pneumatic clay digger loosening hard dirt. With one of these tools, known as "Little David" clay digger, one man can pick as much dirt as five men with ordinary hand picks.

A pipe line was laid alongside the trench to which the compressors delivered air through hose connections. The compressor units were all of the wagon-mounted type; and as the work progressed the pipe was taken up in the rear and carried forward and the compressors moved along, one at a time, to new positions.

The first section of trench, starting in Yonkers, ran along the old Rumsey Road, skirting the city. The surface of the road, composed of stones, clay, gravel, and some stone blocks, was almost like a pavement in hardness. Underneath the hard surface, mostly hard clay, filled with many large boulders of all sizes, was encountered. A trenching machine or power shovel would not have proved at all satisfactory because of the many obstructions.

It was here necessary to break the hard surface either by slow and laborious hand picking or, preferably, by hand labor aided by a power machine, such as the paving breaker. This tool, an air-operated hand-hammer drill, recently adopted by many public utility companies for pavement breaking, was well known for its labor-saving possibilities. Paving breakers, each doing the work of ten to fifteen men with hand sledges and chisels, had directed considerable attention to the savings made possible by pneumatic hand tools and had caused operating companies to favor further labor-saving pneumatic machines.

On Rumsey Road, two paving breakers, with one operator for each tool, rapidly broke up the hard top surface so that it could be shoveled out, and easily covered enough ground in a day to permit the trench digging to go forward as planned. The method of working is seen in an accompanying illustration. Incidentally, the excavating, as shown in this picture, will shortly bring the trench to a paved street where the paving breaker will be employed to even greater advantage.

After the top surface of the road over the trench had been removed, it was then necessary to carry the excavation down to the desired depth, taking out the hard clay and boulders. For this work a very recently developed type of tool, known as a "pneumatic pick," was brought into use to do the picking so that the dirt could be removed with hand shovels. These tools, as shown, have an extension handle so that a man stands in an upright position while "picking." This pneumatic method proved to be very effective and economical. The manner of using the picks is evident from the illustrations.

The pneumatic pick, for those who are not familiar with this tool, consists of an air hammer with a picking blade held in the nozzle end by a suitable retainer. The blows of the hammer piston drive the blade into the dirt or clay so that chunks are either pried loose or sliced away. Such picks have been extensively used in tunneling through clay, where they have made possible reductions of as high as 40 per cent. in the cost of the work. For trench digging, shaft sinking, open cuts, etc., they are fitted with an extension handle. The weight of the tool, complete, is only 29 pounds. The blades used in the diggers are varied according to whether the work is in hard dirt or clay. For clay the blades are about six by eight inches, scoop or shovel shaped. For earth they are five by nine inches, rectangular, with flat face, one-half inch thick at the top and three-sixteenth inch thick at the bottom, with beveled cutting edge.

In ordinary soil, by the pick and shovel method, one shoveler serves one man with a pick. Using a pneumatic pick, one man could keep five shovelers busy. In other words, the man with the pneumatic pick was able to do as much as five men using ordinary hand picks.

The new tool proved very convenient for working in the clay among the boulders. The operator, after short experience, could soon tell if the blade were striking against a rock and, if so, move the tool to another spot without loss of time. Five of these picks were first installed, but a short time later six more were put at work.

The operation of the pneumatic picks was found much less tiring than swinging a hand pick. Using these tools it was also possible for the shovelers to follow directly after the "picker," and more men could be put into a given space without chance of injury incident to a careless swinging of hand picks.

A good many of the boulders uncovered in the path of the trench were too large to be lifted out and had to be drilled and blasted. For this purpose four "Jackhamer" drills were early brought to the job. These one-man, automatically-rotated drills, easily disposed of such obstructions. It was usually a task of only a few minutes' duration to drill a boulder preparatory to firing. Drilling a boulder in this manner and firing required commonly only half a stick of powder to break it, while mud capping requires five or six sticks—a substantial saving by the rock-drilling method.

The next step in the sequence of operations, in which air-operated tools were employed, was calking pipe joints. As previously stated, practically all the gas companies doing work around New York City agree that lead wool

Pneumatic backfill tampers were used to ram all the dirt back into the trench.

Fig. 1.—Paving breaker loosening hard macadam road surface preliminary to trench excavation. Fig. 2.—Pneumatic clay diggers picking hard dirt for hand shovelers. Fig. 3.—Pneumatic hammers calking pipe joints. Fig. 4.—Pneumatic rammers tamping the backfill. Fig. 5.—Portable air compressor supplying power for the tools.

Compressed air was supplied to the various tools by portable compressors placed along the line of the trench. This shows one of the gasoline-engine-driven units supplying 210 cubic feet per minute.

calked in place with pneumatic hammers, makes the very best joint. In fact, in New York City, where the conditions affecting gas lines are severe due to numerous subways, elevated structures and heavy street traffic which cause a great deal of vibration, the pneumatically-calked, lead-wool joint is the only kind which will stand up and stay tight. The lead wool when calked strand by strand ordinarily requires much more labor than the cast-lead joint; but pneumatic calking, on the contrary, takes about half as long as hand calking. The pneumatic method also produces a more uniform and a tighter joint.

In view of these facts, at the beginning of the work, a number of "Little David" calking hammers of the two-inch stroke type were acquired. Six or seven two-men gangs, each gang using two hammers, were kept constantly at work. After the work had progressed for some time, and the organization was running smoothly, an average of two completed joints per man per day was easily maintained. In other words, four man-hours per joint was all the time needed.

Figures obtained from gas companies show the reduction in the time element, with different sizes of pipe, to be as follows:

Size of Pipe	*Time by Hand*	*Time—Pneu. Hammer*
12	2½ hrs.	1 hr.
16	4½ hrs.	2½ hrs.
18	......	3 hrs.
20	7 hrs.	4 hrs.
24	11 hrs.	5 hrs.
30	12 hrs.	6 hrs.
36	14 hrs.	7 hrs.
48	18 hrs.	8 hrs.

In backfilling, pneumatic rammers, each operated by one man, were used. When working in city streets and on roads, it was found that the air-driven rammers had two big advantages. First, they tamped the dirt much quicker, and, second, tamped it much harder. This resulted in a saving of time, and, furthermore, the harder ramming enabled the men to put most of the dirt back in the trench. It was not necessary to carry away as much excess dirt as with hand ramming, and a saving in cartage charges was effected accordingly. Finally, there was no settlement in the trench.

Comparative average figures on hand and on pneumatic ramming disclose a definite saving with the air tools, apart from their other factors, which make them preferable. This is made clear if we consider the competitive performances of the two methods when dealing with trench units of 100 feet in length:

Hand Ramming

2 rammers, 3 shovelmen,=5 hrs.=25 man-hrs.

Pneumatic Ramming

2 rammers, 10 shovelmen,=1⅓ hrs.=16 man hrs.

Saving 9 man-hrs.

At the time of writing this article, the trench had not reached the rocky ground where the customary methods of rock excavation, involving the use of "Jackhamers," would be employed. No records of progress are therefore as yet available for the rock work.

The portion of the pipe-line completed by May 30th, approximately 11,000 feet, permitted the use of all the pneumatic tools previously described and was, indeed, noteworthy by reason of the novel as well as the labor-saving applications of such pneumatic equipment. This work undoubtedly marks a distinct advance over previous methods employed in gas-pipe laying.

The *New York Sun* has pointed out editorially that there is no cause for discouragement if we ponder the figures given out by the Department of Commerce revealing the foreign trade of the United States during the fiscal year of 1922. The value of that trade amounted to $6,378,000,000. It seems that the decline of $3,792,000,000 from the total for the fiscal year of 1921 is accounted for in part by the subsidence of the abnormal commercial activity of the post-war period, and likewise by the increased purchasing power of the dollar.

MAKING THE AIR FREE FOR ALL

IN FRANCE and in Germany the belief is held that man is at the dawn of a marvelous new era in which everyone will be able to bicycle up and down the cool, limitless highways of the air much as humanity at present speeds along upon the hot and dusty roads of the earth. It is predicted that air-bicycles will soon be as common as flivvers and far cheaper to buy. Further, so we are told, they will cost next to nothing to operate.

Intense interest is being taken in the countries mentioned in certain experiments designed to determine whether man can fly as do the birds, that is, by the use merely of his own muscles for motive power.

A Frenchman, Moriss Abbins, an athlete, is the leader in these demonstrations which have been carefully planned by aviation engineers. A queer-looking machine has been designed for Abbins, and on this he lies flat and face downward. His hands can readily reach the two steering handles with which the apparatus is provided; and his legs are brought into action in a way to enable him to develop his greatest muscular power. His feet fit into sockets which are attached to cycle-like cranks; and the latter have been studiously designed in respect to their length and throw. They are coupled by a simple and extremely ingenious bevel-gearing to an air-screw of a new pattern. The angle of the two blades of this propeller can be altered in unison while the screw is rotating. By this arrangement a powerful thrust may be exerted to lift the machine and the rider initially into the air; and when once aloft, by shifting the blade angle, a thrust may be insured which will suffice for the propulsion of the aircraft. Many trials have been made by Monsieur Abbins at the Velodrome d'Hiver, in Paris.

While the pilot is thus accustoming himself to the mechanical drive of the apparatus, special flying wings are being constructed at Fresnay-sur-Sarthe. These wings are to be fitted to the sides of the machine. Like the propeller blades, Monsieur Abbins will be able to adjust their angle so as to rise rapidly from the ground; and, when he is clear of the earth, he can set them in a manner that will permit him to glide through the air with a minimum of muscular effort.

Scientists and aviation experts that have attended the demonstrations have made suggestions, and have come away firm in the faith that further conquests of the air by man may be expected in the near future.

In Germany, Herr Harth, the man who has earned for himself the title of the "wind rider," has made great strides in the direction of motorless flying. Herr Harth's latest achievement is an extraordinary one. Facing the wind, he has ascended, without assistance, from a standstill and has reached an altitude of more than 200 feet. For more than 25 minutes he manoeuvered aloft.

It is said that financiers are prepared to put the man-bird machine on the market the instant it becomes practicable to do so.

Compressed Air Necessary in Making Highway Tests

By CHARLES W. GEIGER

COMPRESSED AIR is playing an important part in the experiments now being carried out jointly by the California Highway Commission and the United States Bureau of Public Roads, with the co-operation of the Columbia Steel Company, on a test highway at Pittsburg, California.

The test highway was built by the Columbia Steel Company, which conducted certain preliminary trials, starting November 9th, 1921, and ending January 28th, 1922. On the first of June tests were made by the California Highway Commission and the Federal authorities mentioned.

The highway is composed of thirteen different sections. Under Section I there have been placed nine Goldbeck cells for the purpose of determining the pressure transmitted to the sub-base by the motor trucks. The recording apparatus is carried in a case, and includes a compressed air tank, an air-hose, a battery, a pilot-light, two wires, and various gages.

In making these tests a motor truck is stopped so that one of the wheels is directly over one of the Goldbeck cells—the cells being placed two feet apart, and extend across the track. The operator next opens the air valve, which admits compressed air into the cell until the air pressure in the cell is equal to the outside or atmospheric pressure—which is indicated by the pilot-light going out. The operator then takes the readings on the dial, which registers in pounds per square inch the pressure transmitted to the sub-base by the truck and its load.

The Government has donated a fleet of over forty motor trucks. Some of these are driven around the test track, part of them in one direction and part in the opposite direction. These motor trucks were operated from November 9th to January 28th, when certain sections became so badly worn that it was necessary to stop the traffic and to make extensive repairs on the weaker divisions.

From 3,000 to 4,000 motor trucks pass over the road each day of testing. Complete checks of results at all stages are being made so that, at the conclusion of the test, the data will be available in practical form and helpful in determining what types of construction are best adapted to certain soil conditions.

As stated previously, before starting the building of the test highway, questionnaires were sent to highway engineers in the State of California, asking for their views as to what should be included in the test and inviting any other suggestions they might make. The State and Federal engineers were also consulted. Hearty coöperation was manifested, and, in consequence, there were thirteen types selected as best conforming to all the views given.

A novel feature of this test highway is its form, which is modeled like a race-track and is elevated at the curves to enable motor trucks to make the turns safely when traveling at 25 miles an hour. From center to center of the rounded ends, the track has a major axis 600 feet long, and the ends are built upon a radius of 75 feet. The pavement or driveway is eighteen feet wide; and one complete circuit of the track involves a run of 1,371.24 feet.

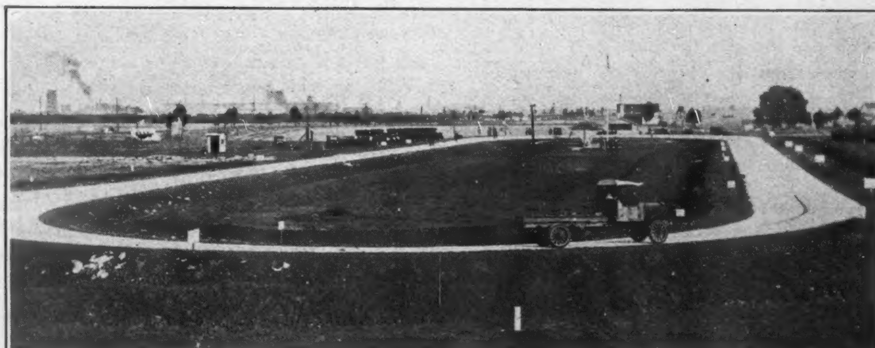
The thirteen divisions of the test highway are of concrete, and the slabs of the various sections range from five to eight inches in thickness. Further details are covered in the accompanying table.

The purpose of building this highway and in making the tests described, is to determine, by observation under identical conditions of wear and on the same subgrade, the relative merits of different materials and of various cross sections and, incidentally, to develop, if possible, an improved type of plain and reinforced concrete pavement. In line with this latter purpose, some of the thirteen sections were reinforced with a special steel of very high tensile strength.

According to Lloyd Aldrich, consulting highway engineer, who is in charge of this research work, engineers in the West have given a great deal of thought to hard-surfaced high-

SECTION	THICKNESS	WIDTH	REINFORCEMENT	SUB-GRADE	REMARKS.
A	5"	18'	20 TONS PER MILE	CRUSHED ROCK	CALIF. TYPE
B	5"	18'	20 " " "	ADOBE	" "
C	6"	18'	55 " " "	"	DIAGONAL REINF.
D	6"	18'	55 " " "	"	" "
E	8"	18'	PLAIN	"	INVERTED CURBS
F	8"	18'	"	"	" "
G	6"	18'	69 TONS PER MILE	"	
H	5"	18'	24 " " "	"	
I	5"	18'	24 " " "	"	INVERTED CURBS
J	6"	18'	PLAIN	"	ARIZONA TYPE
K	5"	18'	69 TONS PER MILE	"	
L	5"	18'	55 " " "	"	DIAGONAL REINF.
M	7"	18'	PLAIN	"	INVERTED CURBS

Table of principal characteristics.



General view of the testing highway at Pittsburg, California.

Recording apparatus used with Goldbeck cells and method of making compressed-air connections.

Making a static test. Rear wheels of truck are directly over observation tunnel. Goldbeck cells are under concrete slab.

ways, but individual engineers have been unable heretofore to prove their theories and designs because of a lack of funds.

Furthermore, it seems that a general feeling has prevailed among highway engineers that perhaps full value was not being received for money expended in the construction of certain types of roads. However, this condition was deemed to exist not by reason of professional incapacity on the part of the engineers, but because they were not given the opportunity for experimentation.

The story of the development of the concrete-test road idea is an interesting one. It is due to the financial backing of the Columbia Steel Company of Pittsburg, California, and to the coöperation of engineers who have wished to make a study of road construction by actual trials. Material for the building of the road was donated; machinery for the work was loaned by machinery houses; and a contractor undertook the job for the bare total of force account and expenses. The test road is eighteen feet wide, and 1,370 feet long on the center line.

COMPRESSED AIR CONVEYING IN FRANCE

THE CONVENTIONAL system in France of conveying materials of all descriptions has been the leather belt. Recently a satisfactory use has been made of compressed air, and this is particularly so in the transportation of granular or pulverized substances.

The latest French design of this method combines the mechanical action of the screw conveyer with the advantages incident to the use of compressed air as a transporting medium. The four chief elements are a specially designed pump, an adequate air supply, suitable mains, and, finally, a manifold containing the distributer valves for the system.

Owing to the fact that the mechanical elements are concentrated at two points, it is possible to enjoy a high degree of reliability in combination with a minimum of up-keep and repair charges. The air pressure within the system is maintained at about 35 pounds per square inch, although the normal working pressure of the compressor plant is never rated below 75 pounds per square inch.

France has found that the use of these compressed air conveyers has reduced power and labor requirements, while supervision has been greatly lessened and simplified. The compressed air system, no matter how exposed, so it seems, is immune to changes due to variable atmospheric conditions. In those mills and factories which have adopted this method of conveying the results have been found highly satisfactory both as regards economy and efficiency. B. K. R.

SCREENING SAND WITH A BLOWER

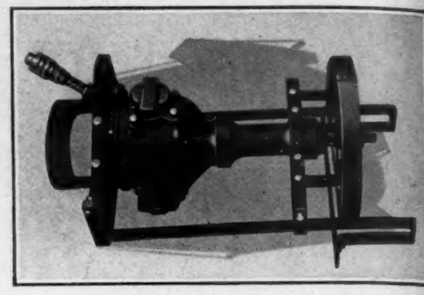
Sand which is used for concrete road building may be too fine as well as too coarse. After the final screening there still remains a considerable portion which is too fine, and exacting specifications insist upon its elimination. In California this is accomplished by allowing the sand to fall in a thin stream from a hopper to a storage bin with a blast of air from a centrifugal blower striking across the falling current. Regulating the air pressure and suitably adjusting the blast nozzle determine the proportion of the undesirable material that is blown away.

PNEUMATIC SAW TRIMS FREIGHT CAR ROOFS

THE USE of a pneumatic saw, fitted with a special attachment, has made it possible to saw off one side of a car roof under repair in three minutes, as compared with one-half hour's time formerly required when doing the work by hand.

Some railroads have designed and constructed an attachment that is fitted to a standard No. 7 "Little David" pneumatic saw, which permits this apparatus to be conveniently used in car repair work.

This special machine and its method of operation are shown in the accompanying illustrations. The outfit consists of a light frame of ¼-in. strap iron, in which the pneumatic saw is supported. Two hooks project from the frame and go over the car roof ends, hooking under the ¾-in. tongue-and-groove pine roofing that is to be cut off. At the extreme ends of these two hooks, there is fastened an-



"Little David" pneumatic saw fitted with attachment for guiding along edge of freight car roof.

other piece of band iron, 12-in. long, that acts as a guide and slides along on the car face. The whole construction is very simple in design and light in weight so that it is easily moved about from one side of a car to the other, or from one car to another.

With this guide arrangement, as mentioned above, the usual straight edge, nailed on the roof, is eliminated. This machine also does away with the need of a scaffold alongside the freight car, as the man remains on the roof to do the trimming.

A 9-in. circular saw is used. A saw guard almost completely covers the saw except for the cutting edge underneath, so that there is no danger to the operator. This saw guard also prevents sawdust from flying up in the face of the workman.

The pneumatic motor, driving the saw, runs at a free speed of 3,000 r.p.m. with the throttle way open under 90 pounds air pressure. The working speed is approximately 1,000 r.p.m., and at this speed and at 90 pounds pressure about one horse-power is developed. The motor is a three-cylinder type of unique design that has proved very adaptable for this service.

This pneumatic saw can also be used on any timber construction, being suitable for sawing off corners and ends, grooving for strap irons, matching timbers, and for a great many other jobs which would prove laborious and require considerable time if done by hand.

Showing the manner of using the pneumatic saw.

Compressed Air in the Realm of Art

The Sculptor's Mallet Now Supplanted by the Pneumatic Hammer

By S. G. ROBERTS

THE UNION of art and mechanical power is, perhaps, nowhere more impressively exemplified than in the studio of the Piccirilli Brothers. These masters of the stone-cutter's exquisite craft have not hesitated to avail themselves of modern facilities that they might put in lasting form the graceful fantasies of the sculptor's creative mind while adhering jealousy to the traditional requirements of their inherited calling.

There is a common belief among the conservative that the time-honored tools of the artistic fraternity were evolved in the course of centuries to meet the needs of master hands, and, therefore, that it would be little short of sacrilege to substitute any instrumentalities that might seem to lessen the demand upon manual skill. Simply because the artisans of the past toiled long and patiently to transform blocks of stone into figures fairly vibrant with life is that any reason why the mallet and the chisel of Phidias, Michelangelo, or Leonardo da Vinci should still be entirely relied upon by the sculptor? The Piccirillis emphatically answer "No"!

Let it be remarked here that these brothers, in their studio in East 142nd Street, New York City, have collaborated with many of America's most eminent sculptors, and it is probably not a misstatement to say that they could not have done this upon the scale they have, with the personnel at their disposal, but for the aid lent them by up-to-date, power-driven agencies. The wearying tax upon the muscles of hands and arms has been greatly lessened by the adoption of tools actuated by compressed air; and the traditional mallet is now used infrequently at the Piccirilli Studio and then mainly for the robust roughing-out blows by which the stone is chipped or cut to the approximate contours of the model.

Courtesy The New York Edison Co.

Putting the finishing touches on a heroic figure of James Monroe by means of the pneumatic hammer. Note the many different tools used by the sculptor in the execution of his work. Any one of these can be employed with his adaptable air-driven apparatus.

Whatever tools may be employed by the sculptural stone-cutter, it should be manifest that only the trained eye and the sure hand can utilize them to the fullest advantage. In the case of the mallet and the chisel, years are required to bring the muscles to the needful nicety of response, as the force of the hammer strokes must range all the way from the drive of a full-arm swing to the gentle tapping imparted by a slight movement of the wrist. Despite its mechanical character, the pneumatic apparatus readily lends itselfs to an equal gamut of control, and, further, possesses executional virtues that are peculiarly its own.

Depending upon the depth of the cut to be made and the nature of the stone—be it marble, limestone, granite, etc., that tool is chosen which best serves the purpose. This is inserted in the sleeve of the small pneumatic hammer, and the air feed for the latter is regulated by a convenient valve agreeably to the strength of the blows desired. At times, the action of a fine chisel is so "smooth" that the cutting is done well-nigh without vibration, and thus, with the lightest touch, the sculptor obtains his most delicate effects. Not only that, but all of his results are realized much more quickly than would be practicable with the old-fashioned instruments of his craft.

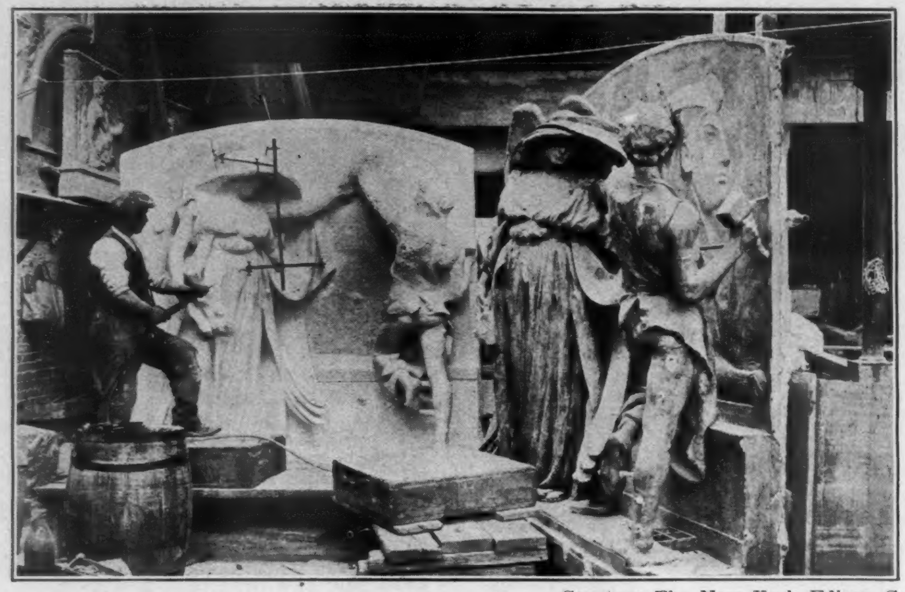
According to the Piccirillis, the air-driven hammers make it possible to reduce the time of execution of any scuptural task to a third of that spent when hand tools alone are employed. It is a curious fact that the mallet-and-chisel craftsmen soon acquire facility in the manipulation of the pneumatic apparatus, and, conversely, are apt to lose some of their dexterity in the use of their quondam instruments. Indeed, unless the work underway is pressing, the artisans will not continue with their old tools when, for any reason, the supply of motive compressed air fails them. This is not hard to understand, for the newer agencies enable them to do things of the highest artistic order and yet to achieve these with a celerity that robs their performances of the sense of labor. The stone takes its finished form fast enough to stimulate the creative faculty of the craftsman.

Courtesy Faustino Nicoli.

Air-driven, stone-carving tools in service in a Madrid marble yard.

Courtesy Wake Monument Co.

At work with a pneumaic stone-carving tool.



Courtesy The New York Edison Co.

Perpetuating in marble the beautiful plaster group at the right symbolical of Death in the act of halting the hand of a young sculptor. The artisan of the present is using the pneumatic hammer to give form to the tragic story of the Master of the Mallet.

The operative air at the Piccirilli studio is furnished by a single compressor which is actuated by a 45-horse-power electric motor. The compressed air is discharged into two receivers where a pressure of about 100 pounds is maintained. The air is distributed by piping to the different workrooms, and there suitable connections are provided for the multiple lengths of hose which deliver the air to the tools at the divers points of activity. The air plant is tucked away inconspicuously in a corner of one of the big divisions of the studio.

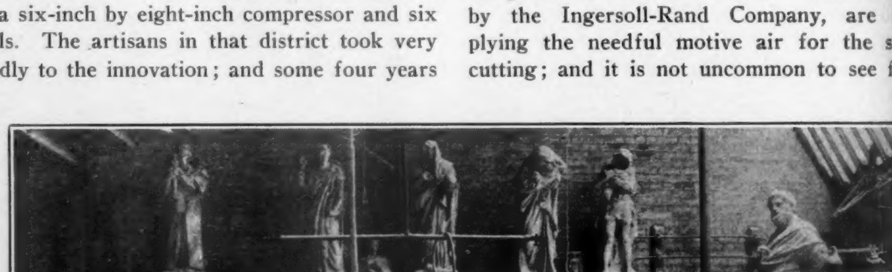
Lest the doubting Thomas persist in his skepticism and argue that the pneumatic hammer is no fit substitute for the mallet, let us mention a few of the fine things done by the Piccirillis in reproducing in stone the plastic models fashioned by such men as Daniel Chester French, Augustus Saint-Gaudens, Frederick William MacMonnies, Paul Bartlett, etc. At this studio were sculptured the four splendid monumental groups which adorn the front of the United States Custom House in New York City, designed by French; there, too, was produced the equestrian statue of Lafayette, modeled by Bartlett, and presented to France by the Knights of Columbus; and from the same source of excellence the Lincoln Memorial in Washington obtained its outstanding and appealing feature, French's colossal figure of the martyred president.

As a matter of fact, pneumatic tools for stone cutting have won wide favor not only in America but abroad; and the following account of their adoption in Spain is fairly indicative of how these modern facilities are steadily winning their way in the Old World. Needless to say, the introduction of air-driven tools in the marble yards of Spain had its setbacks—in fact, it was a long and tedious matter—for not only did the workmen oppose the new instrumentalities on general principle but the employers could not for a good while be brought to see the natural advantages of these useful implements.

About twelve years ago, however, the first modern plant of any note was installed by Tomas Altuna in San Sebastian and consisted of a six-inch by eight-inch compressor and six tools. The artisans in that district took very kindly to the innovation; and some four years later another and larger compressor of the same make was added to the establishment. Both of these machines are still functioning satisfactorily and meeting all the service demands day in and day out, with an occasional night shift thrown in.

Shortly after the San Sebastian equipment was started, an attempt was made by a Madrid contractor to employ pneumatic tools in carving some of the stonework for the post-office which was, at that time, under construction; but the stone-cutters refused to use the apparatus and the contractor was forced to scrap his plant and to do the job by hand. Along about 1913, a small compressed air outfit was erected in the yard of Manuel Molinero, in Madrid, and although he experienced a little trouble in the beginning he stuck to his position and ultimately won out. Other yards followed suit; and to-day there is not a stone-cutting establishment of any importance in Spain that does not boast its pneumatic installation.

A typical equipment is made up of a seven-inch by six-inch, belt-driven compressor providing air for the operation of a score of tools. However, in the case of the new structure for the Bank of Bilbao, in Bilbao, two 9x8 in. compressors, Class "ER-1," manufactured by the Ingersoll-Rand Company, are supplying the needful motive air for the stone cutting; and it is not uncommon to see from



Courtesy The New York Edison Co.

One of the several workrooms of the Piccirilli Studio. Tucked away in the far right-hand corner is the compressor which furnishes the motive impulse for many pneumatic hammers. The larger of the two air receivers stands outside of the housed-in power plant.

Small Ingersoll-Rand belt-driven air compressor such as is used frequently for supplying air power for stone-cutting tools.

50 to 60 of the small pneumatic tools at work at one time.

Aside from increasing production, these up-to-date agencies make it practicable to achieve results which could not be realized, perhaps, by hand. A case in point being the capitals of the columns for a bank building in Madrid. The capitals are veritable works of art and show just what the tools can do in the hands of proficient operators.

Because of their efficiency, air-driven stone-cutting implements in Spain, for example, have increased the use of ornamental marble owing to the fact that the cost of such fittings for buildings, mausoleums, etc., has been brought thereby within reasonable limits; and contractors are now able to accept orders at prices which were considered prohibitively low a few years ago. Also, due to the new markets opened up in this way, the demand for labor has been increased. The workers soon become very skilful in manipulating the tools, and after a few months experience they not only refuse to work by hand but they lay down their hammers if the pressure of the motive air drops below the operating average.

Sir Lionel Phillips, at a recent meeting in London, attempted a graphic description, for the benefit of English shareholders, of a typical South African gold mine. "Envisage," he said, "a line of buildings from here to Hyde Park Corner, not 80 or 100 ft. high, but, say, 2,000 ft. high. The stopes in the mine (whence the gold-bearing rock is extracted) may be looked on as rooms in the houses. In most of the big mines ore is being extracted from various rooms, at all sorts of floor levels, over the lateral distance from here to Hyde Park Corner. If this room where we stand is the central level, we should have to look 1,000 ft. below our feet and 1,000 ft. above our heads, over a distance three miles in length, with thousands of men distributed all over the area. Imagine the organizations involved in lowering, in raising, and in distributing the men to their various stations, and in conveying the ore from these scattered points of attack to central places for elevation to the surface!"

An earth dam which, it is said, will be the highest ever made, is being constructed on the Tieton River, in Washington, by the U. S. Reclamation Service. It will be 232 ft. high by 900 ft. long at the top. The core is being built up from a depth of 100 ft. below the river bed by sinking shafts to the full depth and tunneling along the line of the dam. The tunnel is then extended upward by a stoping process and filled with concrete as the work progresses. In this way the expense of timbering a deep open trench is avoided.

A HARD-ROCK TUNNELING RECORD

IN THE driving of hard-rock tunnels of large cross-section, a record was made at Adit No. 1 on Tunnel No. 3 of the Southern California Edison Company's Big Creek project during the month of March, when a total of 476 feet was driven from one heading.

This particular heading has been in the hardest kind of granite encountered since the opening of the Adit. On many shifts it has been necessary to use three complete sets of drill steel for each hole.

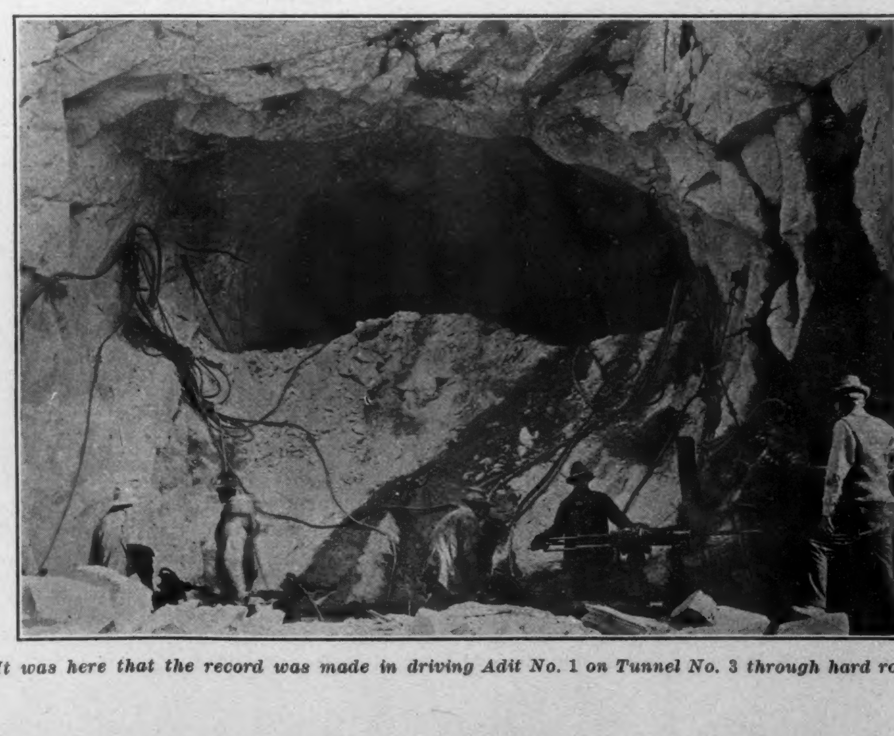
The tunnel section is 21 feet square; and the heading and bench system is being followed. An average of 42 holes is necessary to drill for the heading, and eighteen for the bench. The heading holes average about eighteen feet in depth, while those in the bench may vary from eighteen to twenty feet. At least one round is blasted every 24 hours, making from twelve to seventeen feet progress.

The two rows of vertical holes drilled in the heading are called the "cut holes," and are from twelve to twenty in number. They are so named because of being drilled on the sides. The holes in the bench are called "lifters" and are drilled at the bottom of the bench with a slight pitch downward.

In blasting a round, the cut holes are fired first, next come the lifters in the bench, and last the side holes in the heading. From 1,500 to 2,000 pounds of dynamite are used for each round, according to the quality of rock in the heading.

Eight Ingersoll-Rand drills are used for drilling in the heading and six in the bench. The drilling of a round requires from six to ten hours. Two shifts of 80 men each are worked on this job.

The mucking is done with standard size steam shovels operated by compressed air. The muck cars are hauled in and out of the tunnel by storage-battery and trolley-type locomotives.



It was here that the record was made in driving Adit No. 1 on Tunnel No. 3 through hard rock.

The Submarine Cargo Carrier Will Shorten Trade Routes

Incidentally This Type of Craft Would Open Immense Areas to Commerce

By SIDNEY MORNINGTON

THE SHORTEST distance between two points is seldom the course followed by seafarers when they travel from port to port across the broad expanses of the world's watery wastes. For hundreds of years navigators generally have skirted around continents and have sailed or steamed many thousands of needless miles in carrying commodities to and from foreign lands.

Occasionally, some bold sailorman or far-seeing genius has protested against this practice, and has pointed out that it should be possible to traverse the Arctic Ocean and thus to save much time and money in voyaging between certain great maritime centers. Indeed, a few venturesome explorers have actually proved that this can be done in small craft.

Now comes Simon Lake with a type of submarine cargo carrier which is especially designed to enter northern waters and to make little of the ice which may be found there. He is convinced that vessels of this kind can not only shorten ocean runs by thousands of miles but that they can render invaluable aid in opening up tremendous territories, teeming with natural wealth, which are at present virtually inaccessible.

To most of us the submarine is but one of divers grim instruments of warfare. It is something of a relief to find that one of the foremost pioneers in this branch of naval architecture has devised a field of peaceful employment for subaqueous craft.

THE GARDEN of Eden was probably never located north of the Artic Circle, although explorers have discovered in the very heart of Greenland a region singularly at variance with its frigid surroundings. However, we do know that more and more of Canada is lending itself to cultivation, and that sub-Arctic sections of the Dominion are to-day yielding increasing quantities of cereals. Again, Alaska is rapidly developing as a source of foodstuffs and essential raw materials; and, finally, there are enormous areas in Siberia and northern Russia which have only to be opened to trade and systematically exploited to give to hundreds of millions of people amazing quantities of grain, timber, minerals, etc.

Within the past few years, several expeditions have penetrated both the Arctic and the Antarctic portions of our globe, and most of these have had commercial inspiration. The explorers have found in some places unsuspected measures of coal or other mineral wealth; and to their infinite surprise, in numerous instances, the isolated lands have abounded with animal life. Further, certain of these remote regions of this sphere of ours are especially fitted for the establishment of stations from which to prosecute the whaling industry. The one outstanding drawback to these tantalizing territories of actual or potential plenty is their inaccessibility. With accustomed facilities they are difficult to reach even when made more approachable by the mild seasons; and the hazards, then, are commonly too great to warrant ordinary business enterprise.

The inhospitable nature of the Arctic Ocean has interposed for ages a barrier to waterborne trade bound to and from the Atlantic and the Pacific, although geographers and navigators have long known that a northern route would shorten the distances between some ports lying on the shores of these oceans. Seventy-odd years ago, Sir Robert McClure made it clear that ships might pass from the Atlantic into the Pacific, and vice versa, by carefully threading the ice-filled waters along the northernmost coasts of North America. And during 1878-'79, Nils Adolf Erik Nordenskjöld traversed the Arctic Ocean, in his little craft the *Vega,* following the seaboard of Siberia eastward from the Atlantic to Bering Strait and thence southward into the Pacific. Scientifically, the feats of those pioneers were interesting, but their deeds gave little if any encouragement to the practical-minded of the shipping fraternity. Apparently the risks were too grave; and it is very doubtful if any marine underwriter would have been willing to insure either ship or cargo taking such a course.

And what has been the consequence of this attitude on the part of the maritime world? The preponderance of international ocean trade, while not literally dodging around Robin Hood's barn, has, nevertheless, largely held to shipping lanes which have added hundreds, yes thousands of miles to the geographical distances between starting and terminal ports. This lengthening of voyages was tolerated in the days gone when industrial life moved everywhere at a leisurely pace; and when the steamer crowded the sailing ship to the wall, the watery wastes between the markets of the world began, in effect, to shrink. Express liners and relatively fast freighters brought far-flung sections of the globe, in point of time, closer to one another. Even so, the man of business realized that speedy craft alone would not suffice to promote the exchange of commodities among the nations, nor facilitate passenger traffic and postal communication to the fullest extent. Therefore, what has happened? Canals have been cut to link adjacent bodies of water and thus to abridge the journeys imposed by obstructions of Nature's making. These artificial channels have entailed outlays of hundreds of millions of dollars.

How, then, can circumstances be bettered so as to save time and still further shorten voyages to and from sections of the Seven Seas? How, in fact, can these desiderata be realized without the digging of other canals, or without the building of still costlier ships of greater speed? In short, is there any answer to this problem which is pressing forward and calling for a solution in the near future? It seems there is an answer; and Simon Lake says it is the cargo-carrying submarine. This kind of craft, he tells us, will be able to navigate the waters of the Arctic Ocean and to negotiate other seas and bays where ice is so often a hindrance to the passage of surface shipping.

According to such authorities on polar conditions as Peary, Nansen, Stefansson, and Hansen, field ice in the Arctic Ocean seldom, if ever, exceeds fourteen feet in thickness in the winter season. And it is a rarity for the ice to cover the ocean for a stretch of more than 25 miles before exposing an area of open water. In the summer time the depth of the floes diminishes and the ice softens and grows slushy—a state which is apt to impede if not to halt the advance of the usual type of vessel. These details are mentioned purposely that the public may appreciate just how Mr. Lake has planned to take advantage of them or side-step them, so to speak, in establishing new trade routes between the Atlantic and the Pacific and in opening up regions of untold natural wealth.

Most of us can recall the exploits of the German subaqueous freighter *Deutschland* during a critical period of the World War; and it is fairly fresh in our memories how she managed to make several trips across the Atlantic and to escape the while the British fleet on the lookout for her both in American and European waters. She evaded the enemy not by reason of speed but because she was able to sink below the waves and thus to dodge the foe upon the surface. Mr. Lake intends that his cargo-carrying submarines shall avoid floating obstructions in the same way. That is to say, instead of skirting them, as the normal navigator does, he proposes to dive beneath them and to come up only when the barrier is past.

For the sake of those who may not be familiar with ice conditions in the Arctic Ocean during the so-called open season, it should be remarked here that icebergs do not then prevail in that body of water north of Russia and Siberia nor, as a matter of fact, in the water to the north and immediately eastward of Alaska. Therefore, the subaqueous freighter would have to contend only with field ice or floes of comparatively moderate depth. Indeed, the plan is to delay operations until the ice has been softened by the spring and early summer sun, and to continue until the ice hardened again sufficiently to resist the smashing force of the submarine. Icebergs do occur in Hudson Strait, Davis Strait, and off the coast of Labrador; and the navigator would have to go around them as their submerged depth might be too great to justify trying to pass beneath them.

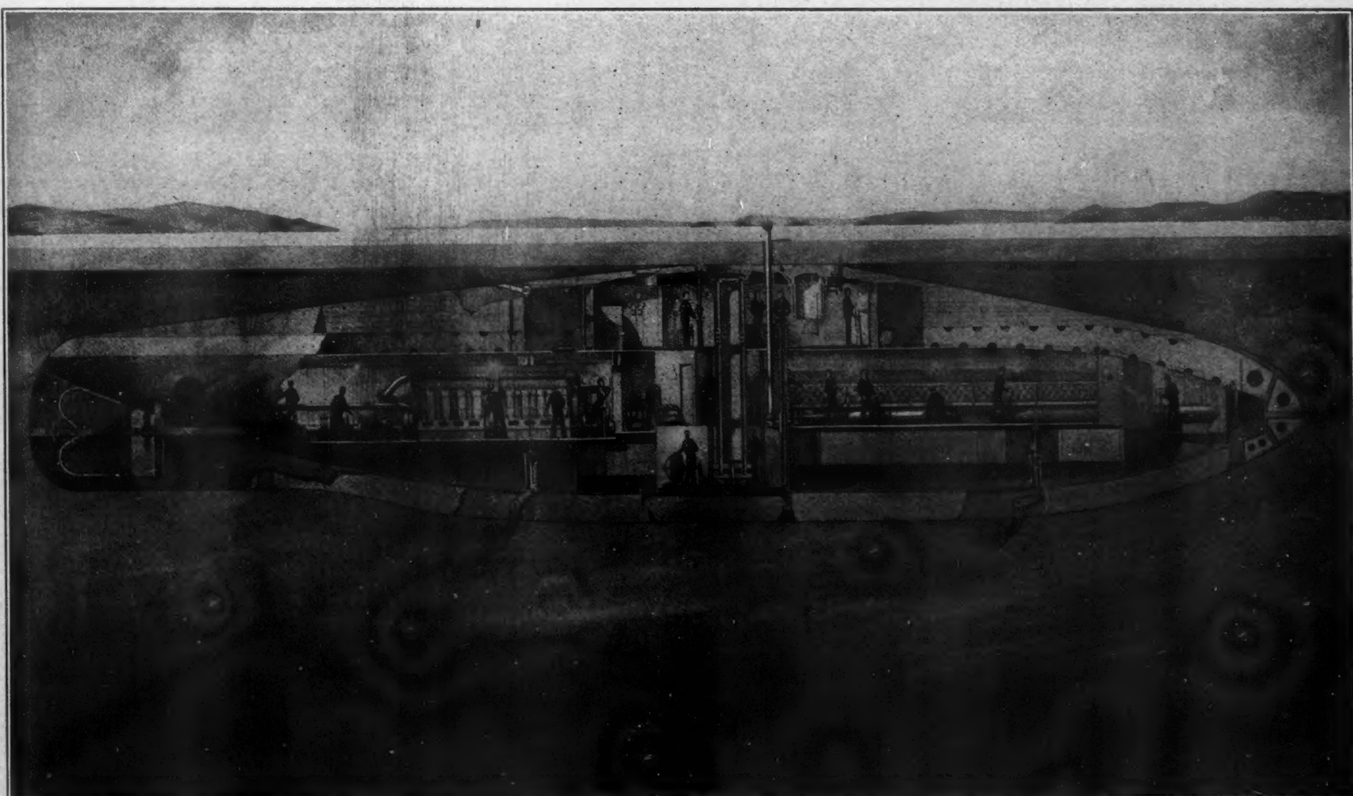
What, specifically, would be gained by tapping the resources of Siberia? Mr. Lake declares that merchantmen of the type advocated by him would open up an immense section rich in gold, silver, platinum, iron, coal, furs, timber, and grazing lands, some portions of which are reported to be the biggest wheat-growing areas in the world. He points out: "Three of the rivers in this vast territory, the Obi, the Yenisei, and the Lena are each much longer than the Mississippi, and these waterways, emptying into the Arctic Ocean, drain an expanse more extensive than that of the whole of the United States, and provide, the while, means for cheap transportation from the heart of the country to their mouths during the summer months. At their outlets, ports could be established from which submarine freighters could move various raw materials, in bulk, to continental markets. As we all know, the port of Archangel acquired added importance and new significance during the World War; and there is no reason why kindred centers of commerce could not be built at the entrances of these northern rivers, inasmuch as navigation would be open for from four and a half to five months annually."

But apart from the possible service of the subaqueous cargo ship in developing Siberia and northern Russia, let us see what the traversing of the Arctic Ocean would mean in the way of shortening the journey to and from certain seaboard trade centers. Apropos of this, Mr. Lake says: "I am sure no one can deny the value of a type of craft that, on the same tonnage, would be able to carry an equal amount of cargo between two ports in 28 days as against 46 days. And, by way of explanation, let us assume that the voyage is from Liverpool to Yokohama.

"The distance between Liverpool and Yokohama, via the Panama Canal, is 12,260 miles, and by way of the Suez Canal it is 11,105 miles. We will suppose that a ship, loaded with 10,000 tons and making ten knots an hour, starts out from Liverpool on the first of July,

Table of Distances

Distances Nautical Miles	Via Arctic Ocean	Via Suez	Saving Single Trip	Saving Round Trip	Via Panama	Saving Single Trip	Saving Round Trip
Liverpool to Petropavlovskii, Siberia	5350	12505	7175	14350	11200	5870	11740
Liverpool to Vladivostok, Siberia	7050	11250	4200	8400	12450	5400	10800
Liverpool to Sitka, Alaska	6105	14655	8550	17100	10586	4481	8962
Liverpool to Nome, Alaska	4425	13705	9280	18560	11990	7565	15130
Liverpool to Seattle......	6686	16653	9967	19934	8615	1929	3858
Liverpool to San Francisco	7051	16335	9284	19568	7845	794	1588
Liverpool to Honolulu....	7046	14244	7198	14396	9320	2274	4548
Liverpool to Manila......	8650	9570	920	1840	14082	5432	10864
Liverpool to Hongkong...	8500	9664	1164	2328	14224	5724	11448
Liverpool to Yokohama...	6850	11105	4255	8510	12260	5416	10832
New York to Nome, Alaska	6660				7945	1285	2570
New York to Petropavlovskii, Siberia	7010				8594	1584	3168
New York to Vladivostok, Siberia	9310				9844	534	1068
New York to Yokohama...	9135				9654	519	1038



An under-ice military submersible designed by Simon Lake in 1905 for service in the Baltic Sea. Certain features of the type are embodied in his recent plans for a subaqueous cargo carrier. Among these is the housing or so-called telescoping conning tower equipped with a series of ice cutters mounted on the heavy cast-steel top of the revolving tower. In this drawing the submarine is shown lying against the under side of field ice with its rotary periscope projecting above the ice for observation. The periscope is provided with cutters to effect the needful penetration. The spiked wheel, carried by the pivoted arm at the rear of the conning tower, is designed to engage the ice and to operate a speedometer. In this craft compressed air was to be used to expel water ballast, to discharge torpedoes, to refresh the atmosphere in the boat, and to function various military and safety features.

and takes the shorter course to Yokohama, i. e., through the Mediterranean, the Suez Canal, the Red Sea, the Indian Ocean, and thence eastward to the Pacific. If she maintains a speed of ten knots she will cover the interval in 46 days, and reach her destination on the 15th of August. If we allow her ten days in port for unloading and reloading, and she sails for Liverpool on the 25th of August, she will be back at the English port on the 10th of October. For the sake of comparison, we will say that the freight charges are $7 a ton, and that it costs $500 a day to operate the steamer. Should the vessel have to pay canal tolls, each way, at the rate of $1.20 a ton, then the total profit will amount to $65,000 for the round trip.

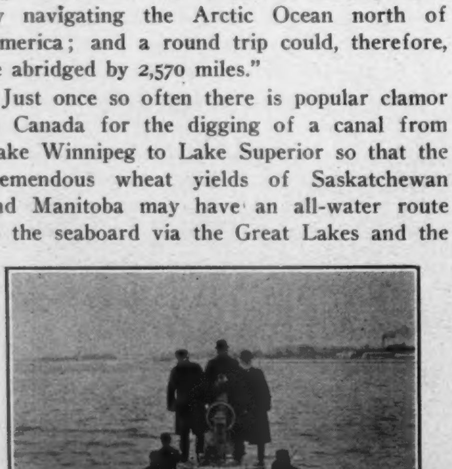
"On the other hand, what will a cargo-carrying submarine of similar capacity and like surface speed do over the Arctic-Ocean route between the two ports in question? By reference to a table of distances we find the ocean run north of Russia and Siberia between Liverpool and Yokohama to be 6,850 miles. Leaving Liverpool on the first of July, the subaqueous merchantman will arrive at Yokohama on the 29th of the same month—eighteen days ahead of her rival. Taking ten days for unloading and reloading, then the under-ice craft will depart on August 8th and may reasonably be expected to make her home port by September 5th. Here is a saving of 36 days; and as there are no tolls to be paid the gross profits will be $107,000—$42,000 more than that earned by the conventional surface boat! If the object be to move goods by water from New York to Nome, Alaska, the journey, as shown by the table accompanying this article, can be shortened 1,285 miles by navigating the Arctic Ocean north of America; and a round trip could, therefore, be abridged by 2,570 miles."

Just once so often there is popular clamor in Canada for the digging of a canal from Lake Winnipeg to Lake Superior so that the tremendous wheat yields of Saskatchewan and Manitoba may have an all-water route to the seaboard via the Great Lakes and the

This map shows new trade routes by way of the Arctic Ocean as compared with some of the usual trade routes.
Route No. 1, Liverpool to Yokohama via Arctic Ocean, 6,850 miles.
Route No. 2, Liverpool to Yokohama via Suez Canal, 11,105 miles.
Route No. 3, Liverpool to Yokohama via Panama Canal, 12,260 miles.
Route No. 4, New York to Yokohama via Arctic Ocean, 9,135 miles.
Route No. 5, New York to Yokohama via Panama Canal, 9,654 miles.

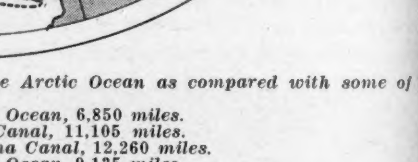
New York State Barge Canal or the St. Lawrence. In opposition to this, Mr. Lake suggests carrying the grain to Port Nelson on Hudson Bay to be transhipped thence by submarine freighters to Liverpool. By way of the sub-Arctic, Port Nelson is about 3,200 miles from the English port, and more than 1,000 miles nearer Liverpool than the run via either the New York State Barge Canal or the St. Lawrence River. Mr. Lake explains:

"The establishment of shipping bases at Port Nelson and Port Churchill, and likewise at the mouth of the Mackenzie River, would open up quite 1,000,000 square miles of territory and link it by comparatively cheap transportation with markets on both the Atlantic and the Pacific. An old French-Canadian priest, resident at Port Churchill for over four decades, has found that Hudson Bay is usually navigable for six months of the year; and such ice as might be floating in the Bay and its approaches during the early spring could, undoubtedly, be underrun or plowed through by a vessel of my type. My confidence in the type is based upon experiments made by me in Narragansett Bay during the winter of 1903-'04 and in the Baltic Sea somewhat later. We repeatedly demonstrated that our submarines could reach the surface by breaking up through the ice."



A Lake submarine after she had come up through a heavy floe of ice. This boat was purchased by the Russian Government.

It might be well at this point to give a general description of the unique order of craft for which Mr. Lake has prepared detailed plans. Indeed, it is no breach of confidence to say that it was for this very design that estimates and specifications were submitted to the U. S. Shipping Board at an especially anxious period of our participation in the World War and probably a large number of these vessels



The powerful ice-breaker, Ermaok designed especially to buck the ice in the Baltic so as to keep passages clear for other steamships. The Ermack attacks the ice edge on and, therefore, in a direction in which the ice can offer its maximum resistance.

would have been taken in hand had not two of the leading officials of that organization come to loggerheads over other problems, and resigned. The *Deutschland* was of 1,700 tons submerged displacement, while the boats proposed by Mr. Lake were of 13,000 tons submerged displacement in salt water. This, in itself, will give some notion of the startling advance he contemplated.

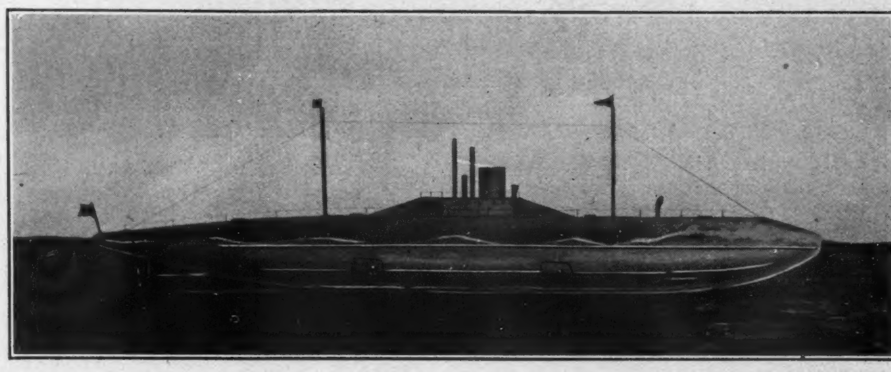
Let us speak of the group as the *North Star* class. The type-ship would be 365 feet over all, would have a molded breadth of 45 feet, and a molded depth of 42 feet. Whether driven by steam or Diesel engines, she would be able to make a speed of ten knots an hour when running on the surface, and this could be assured with a propelling plant of 1,500 indicated horse-power operating a single screw. For under-water work, the intention is to provide storage batteries and electric motors capable of maintaining a speed of from three to five knots an hour for 24 hours without recharging the accumulators. This reserve of electrical energy would guarantee plenty of leeway and furnish ample current for lighting, cooking, and the functioning of other electrical apparatus. When fully laden, the cargo spaces would hold 7,500 tons of freight. The *North Star* would carry enough liquid fuel for a radius of action of thousands of miles.

The ordinary surface ship is a more or less box-shaped structure with flat sides and decks. Mr. Lake says that his calculations show that by adopting a circular cross-section he can build subaqueous freighters sufficiently strong to withstand hydrostatic pressure at a depth of 600 feet! Not only that, but he declares that his boat, of the same cargo tonnage as that of a given surface steamer, will actually require less material in her construction than the conventional craft.

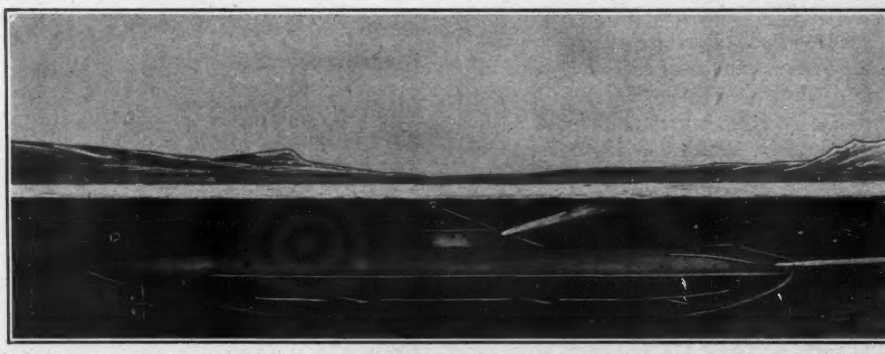
In surface trim, the *North Star* would normally have a reserve of buoyancy of about 1,500 tons, and her minimum reserve of buoyancy, when totally submerged, would be between four and five tons. Therefore, her buoyancy would be altered by taking in or expelling water ballast. In controlling the expulsion of this ballast compressed air would be utilized; and, accordingly, the ship would have a compressor plant and a number of steel flasks capable of holding compressed air at a pressure of approximately 2,000 pounds per square inch. Compressed air would also be used for refreshing the atmosphere within the *North Star*, if need be, during a prolonged submergence; and compressed air would, likewise, be employed for various other purposes—indeed, the vessel could not be operated without this motive medium.

The illustrations show that the *North Star* carries a superstructure modeled more or less after the upper form of a razor-back hog. In other words, the main deck is surmounted by a heavy steel rib or frame, and this is supported in the center by a conning tower, also of sturdy construction. The front and rear of the conning tower are shaped like double plowshares, and when advancing partly submerged, against the ice, these serve to lift and break the ice and to turn it over and outward after the fashion of the farmer's plow when forging through turf. Thus a channel is cleared for the passage of the conning tower.

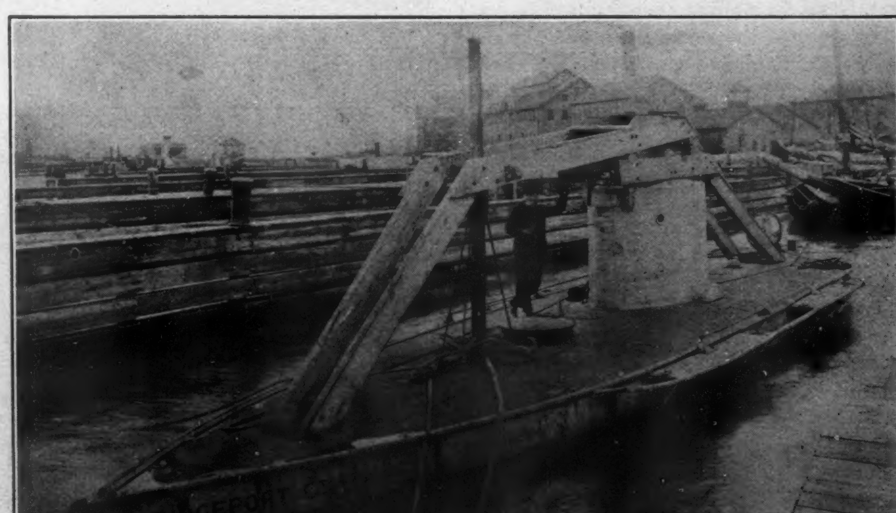
The object of the narrow rib is to crack the ice when the submarine is going forward with her bow slightly inclined. As Mr. Lake puts it: "I believe this arrangement will avoid the necessity of ever submerging after the spring sun has begun to soften or to 'rot' the ice; but if the craft should encounter stiff ice, that we can't drive through in this way, we can always reduce our positive buoyancy far enough to enable us to underrun a floe. It is surprising how rather heavy ice can be dealt with in this manner. Even in the case of a submarine of only 250 tons total displacement I was able to cut a path through ice which stopped big merchantmen and small cruisers. This is because the rib exerts a wedge-like action against the underside of the ice; and as the area of the lifting surface is small and the upward force considerable the ice is readily



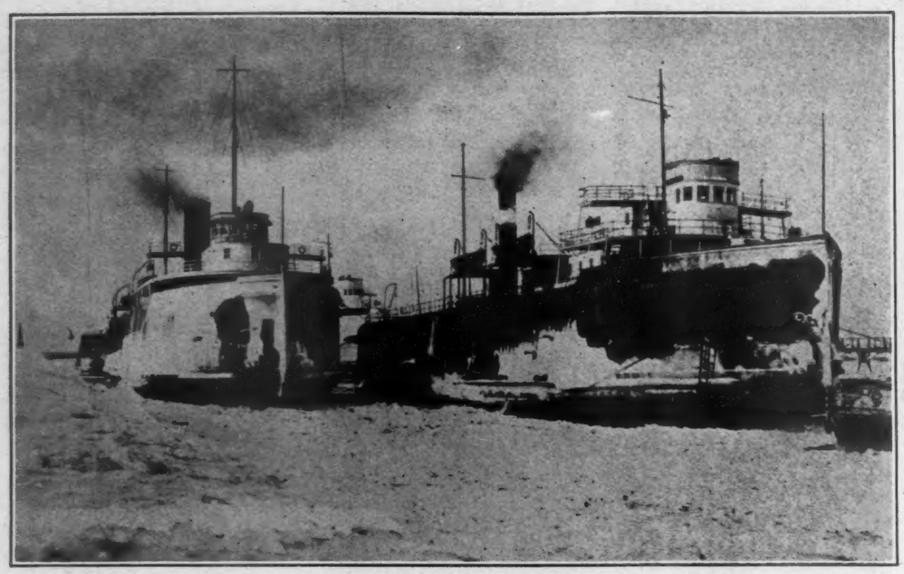
A drawing of the submarine freighter as she would appear when running at the surface with 1.500 tons of reserve buoyancy. Her periscope, wireless-telegraph masts, conning tower, etc., are elevated. In this condition the vessel could be propelled either by a steam or a heavy-oil engine at a rate of ten knots an hour.



The North Star, completely submerged, with only four or five tons of reserve buoyancy. In this condition the vessel would be driven by electric motors. She would maintain contact with the under surface of the ice by the trolley arm which is equipped with a speed-recording wheel. The speed of the boat would be between three and five knots an hour. Note that the elevating conning tower and certain erectable features are housed.



Lake's pioneer effort to produce a submarine especially fitted for under running thick ice. This boat was tentatively equipped with skids of heavy timber, and the upper portion of this structure was arranged to act like the blades of skates when sliding along in contact with the nether surface of ice.



Steamers on one of the Great Lakes harbor bound by reason of ice.

broken. Solid or new ice eighteen inches in thickness has repeatedly been smashed by this procedure."

When traveling beneath the ice, the *North Star's* buoyancy would be reduced to about four or five tons—i. e., there would remain a rising or lifting impulse of that measure. In that condition, the boat would be in contact with the nether surface of the ice by a trolley-like arm elevated above the ship; and by means of a rotating wheel at the end of this arm it would be practicable to record in the conning tower the distance covered. Because of the erosive wash of the water, Mr. Lake is convinced that the under surface of most ice would be comparatively smooth. The *North Star* would be equipped with a revolving, telescoping tower armed with cutters. This feature is designed to bore up through ice several feet thick so as to permit observation and to gain access to the atmosphere.

While intended primarily for the navigation of Arctic or sub-Arctic waters, the submarine freighter may be utilized to advantage in less rigorous parts of the world when not engaged in dodging or diving beneath fields or floes of ice. The ordinary ship, caught in a storm, must ride out the gale as best she may in the sweep of the blast and exposed to the pounding surge of angry billows. It is under just such circumstances that a boat's cargo may be shifted by her rolling and pitching; or the friction set up by even moderate movement may suffice to start a conflagration somewhere deep down in a freight-packed hold. The submarine merchantman, on the other hand, can submerge and go on her way, at lessened speed, for a day at a stretch, at a depth that will keep her beyond the reach of wave action. This would minimize structural stresses and the physical drains upon the personnel while eliminating the risks of a shifting cargo or the propagation of fire. In conclusion, Mr. Lake is positive that his submergible craft will be safer to run at all times than any surface steamer. The military submarine achieved much that was generally deemed impossible of accomplishment prior to 1914. Why, then, should the commercial submarine not fulfill Mr. Lake's prophecy—building as it does upon the attainments of its fighting sister type?

FOUR NATIONAL ENGINEERING SOCIETIES ORGANIZE EMPLOYMENT SERVICE

AN EMPLOYMENT service for engineers of every variety of training and experience is conducted gratuitously by the four National Engineering Societies of the United States. This organization brings in touch with various business men the services of 50,000 trained technical men who are members of these societies. One of its objects is to show to divers commercial houses the aid which engineers are rendering to others in the same lines and to help these firms and corporations to secure similar assistance.

Men of engineering training are prominent in all branches of commercial endeavor; and their creative ability is recognized as being of great help in the building up of the Nation's wealth.

The service is in a position to supply the readers of COMPRESSED AIR MAGAZINE with civil, mechanical, electrical, designing and sales engineers; and with production men, superintendents, and executives trained in various industries. Mr. W. V. Brown, who is in charge of this work, is located in the United Engineering Building, No. 29 West 39th St., New York City.

SPONGY SOAP

A recently issued U. S. Patent (No. 1,41[illegible]015, April 25, 1922) describes a new form of soap and the process of its production by the aid of compressed air.

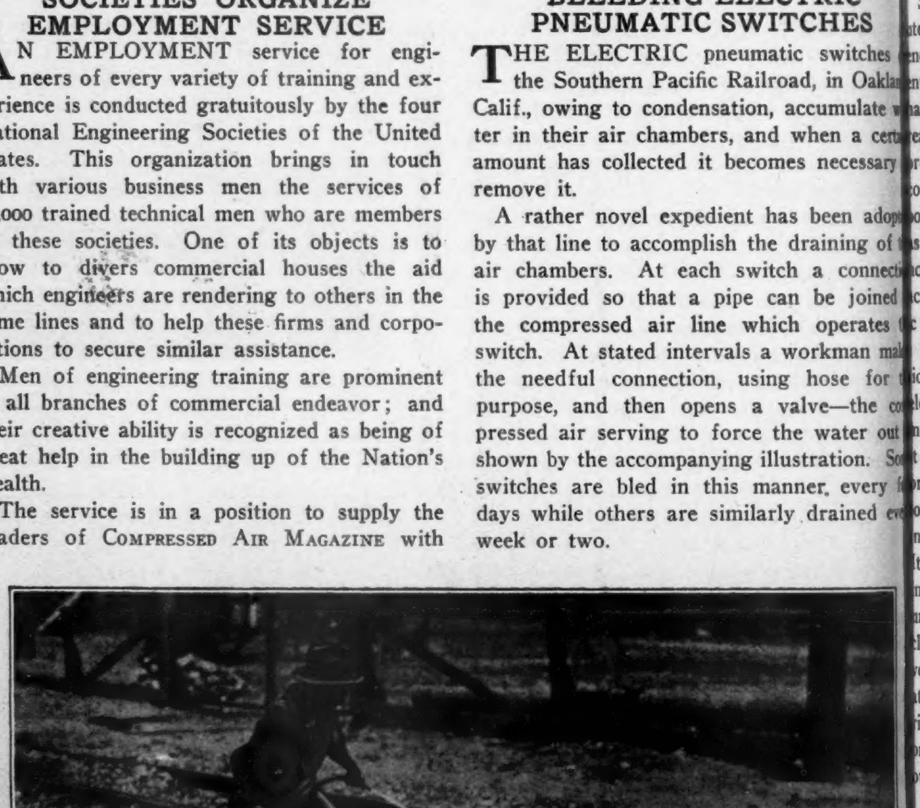
The soap is spoken of as in the form of a fluffy aggregate of minute cells filled with air and having extremely thin connected walls formed by the soap, said soap being substantially instantly soluble in warm water.

The process of manufacture is described, in one of the claims of the patent, as the disseminating of a multitude of air bubbles throughout the soap while the soap is in a molten, viscous condition; the diminishing of the pressure under which the aeration took place so as to expand the air bubbles within the mass of soap; and the permitting of the puffed mass thus produced to cool.

BLEEDING ELECTRIC PNEUMATIC SWITCHES

THE ELECTRIC pneumatic switches of the Southern Pacific Railroad, in Oakland, Calif., owing to condensation, accumulate water in their air chambers, and when a certain amount has collected it becomes necessary to remove it.

A rather novel expedient has been adopted by that line to accomplish the draining of the air chambers. At each switch a connection is provided so that a pipe can be joined to the compressed air line which operates the switch. At stated intervals a workman makes the needful connection, using hose for this purpose, and then opens a valve—the compressed air serving to force the water out as shown by the accompanying illustration. Some switches are bled in this manner every few days while others are similarly drained every week or two.



Compressed air to bleed electric pneumatic switches on Southern Pacific Railway.

To Boom American Business By Motion Pictures

The Latest Reel Shows the Many Uses of Compressed Air in Industrial Fields

BOTH ABROAD as well as here at home there is a continually growing demand for a fuller knowledge of American methods of manufacture and of the services to which American products are applied. To disseminate this information it is now the intention of the Federal authorities to utilize the graphic story-telling capabilities of the "movies."

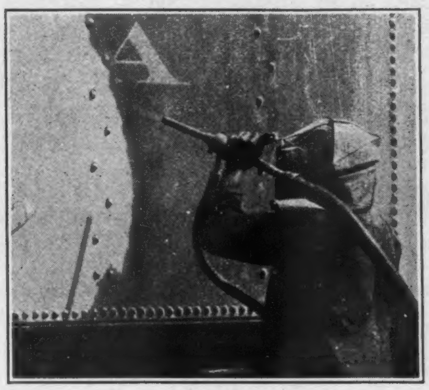
A short while back, the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce completed arrangements to turn out in this country motion-picture films illustrating methods of production and the employment of American machinery and kindred manufactures. In this undertaking, the United States Bureau of Mines is coöperating; and it will be recalled that the latter organization has in recent years got out a number of films, showing divers phases of the mining and the metallurgical industries, which have proved very successful throughout the United States and, in some instances, in foreign countries.

Several of the new films have been distributed, and the reaction to them has been most encouraging. The very latest in hand is one entitled The Story of Compressed Air, which has been produced by the United States Bureau of Mines in collaboration with The Compressed Air Society. Not without reason, it is confidently expected that this film will grip both the imagination of the man in the street as well as of his brother in industry who may not yet be aware of the very broad field of activity in which compressed air and pneumatic apparatus play conspicuous parts.

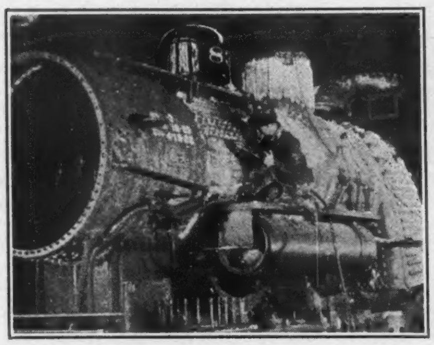
The introductory caption of the film in question points out that compressed air, steam, and electricity are our great power-transmitting mediums. Each has characteristics that make it most suitable for certain applications. Compressed air has figured in an outstanding fashion in helping along the world's progress and in speeding up development in many directions. It is indispensable in mining, quarrying, and in a wide diversity of engineering tasks or undertakings. In the realm of industry, it cleans, paints, and polishes; it pumps, and conveys liquids and solid materials; and it operates tools for boring, cutting, chipping, and riveting. In short, it is used in a thousand and one ways to hasten manufacture, to improve output, to reduce expense, and to lighten labor.

In order that the uninitiated may realize just how the free atmosphere is drawn upon for service at the will of man, some of the pictures illustrate the manner in which the air we breathe is sucked into a compressor, therein compressed, and thereby charged with latent energy to do all sorts of work. Modern air compressors run the whole gamut from small garage pumps to huge units in plants where great volumes of air are required. These machines are variously driven by steam, by electricity, or by oil engines.

Drilling rock and ore in mines is strictly a compressed-air job; and by means of this motive force shafts, tunnels, and stopes are advanced rapidly and at low cost. But this does not tell the whole story of air's service in these underground workings. The air exhausted from the penetrating drills supplies the toilers continually with the breath of life and keeps the subterranean atmosphere fresh even though the men may be laboring hundreds of feet down or remote from the light of day.



Sand blasting a locomotive tender preparatory to repainting.



Pneumatic hammers are used extensively in locomotive repair work.

The air-driven rock drill is indispensable in the quarry.

Compressed air is employed in stuffing the ubiquitous "hot dog."

It is not possible in this brief review to more than hint at the wealth of information so well and so quickly presented by the film, itself. However, let us mention some of the titles accompanying the 121 pictures shown by the reel:

Diamond core drills furnish samples of rock from great distances below the earth's surface.

Air speeds production and cuts cost in the quarry industry.

Air channelers cut smooth walls while air drills, large and small, help dig the Niagara Canal.

Portable compressors bring air to the job for the road maker or the street contractor.

Tamping railroad ties by means of compressed air.

Air-driven portable hoists have many applications.

Rock-loading machine small enough to work in a tunnel six feet high.

Compressed air is used to pump deep wells and to handle all kinds of chemicals.

The modern foundry needs air which rams molds, sifts sand, removes cores, and cleans, chips, and grinds castings.

Water agitated by air renders ice clear in the modern ice-making plant.

Nearly all glass is blown by compressed air.

Compressed air is used in the humidifying system of textile mills.

Drilling, reaming, and tapping of metal is done largely by pneumatic tools.

The air riveter is the machine-gun of modern industry.

Boiler and condenser tubes are both cleaned and packed by compressed air.

"Everything but the squeal" goes in quick by air: at least such is the case when stuffing sausage.

Testing containers for leakage by the use of compressed air.

The cement-gun has many uses.

The film for The Story of Compressed Air has been made by The Rothacker Film Manufacturing Company of Chicago, and in the staging of the pictures that concern has been ably assisted in the field by a corps of experts thoroughly familiar with compressed air apparatus and their manifold applications.

Mr. Tiry H. Miller had direct supervision of the camera work.

Only three states, New York, New Jersey and Pennsylvania, have any laws regulating the hours of labor.

Compressed Air Magazine

—Founded 1896—

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EDITORIALS

CONSTRUCTIVE THOUGHT NOT PESSIMISM NEEDED NOW

NO ONE can justly deny that the World War made a mess of things; and it is equally plain that the peace treaties have not, in themselves, yet brought calm and prosperity to the nations most concerned. It was not humanly possible for the men responsible for those conventions to see clearly and to anticipate a multitude of consequences while working in an atmosphere still beclouded by the smoke of battle.

The President of COMPRESSED AIR MAGAZINE, Mr. WILLIAM L. SAUNDERS, has recently taken issue with Mr. OTTO H. KAHN, an eminent American financier, whose expressions abroad have, in all probability, given an erroneous impression of the attitude generally held in the United States towards Europe's immediate problems. Mr. SAUNDERS points out that now is certainly not the time for "destructive, superlative criticism", and he very properly remarks that the situation cannot be improved by the utterance of a discordant note. Instead, the task is to nurse wounded Europe back to health and to self-sufficiency by constructive suggestions; and Europe's well-wishers in America are heartily disposed thus to play their part in mending matters.

If the peace treaties are in any way deficient it is not because their basic principles are wrong. Unexpected conditions and events have made it difficult to draw directly from these treaties the guidance needful. Therefore, Mr. SAUNDERS offers this rational remedy: "As with the Constitution of the United States, so let us now amend and perfect these treaties as the wisdom of experience may dictate."

A MONUMENTAL EXAMPLE OF CONSERVATION MADE POSSIBLE BY THE VACUUM PUMP

ACCORDING to data compiled recently by the United States Department of Agriculture, there was put up in America during 1921 no less than 1,464,163,000 pounds of condensed milk, including both the sweetened and the unsweetened kinds. To accomplish this, it was necessary for the 200 and more plants engaged in the business to treat a total of 3,660,408,000 pounds of whole milk. Whole milk, be it understood, is the milk just as it comes from the cow and carrying the full percentage of butter fat.

Simple arithmetic reveals that for every pound of condensed milk there were required two and a half pounds of so-called raw or fresh milk; and, therefore, during the process of condensing, the water content of the milk was lowered in corresponding ratio. What does this signify economically? Normally, milk is made up of quite 87 per cent. of water while the remaining thirteen per cent. is the portion which is of really vital concern as a foodstuff. A pound of condensed milk carries only 30 per cent. of water and this difference between the two commodities has rather far-reaching consequences.

Most of us are alive to the fact that it costs something to place anything in storage; and the more space occupied by goods while in a warehouse the greater the outlay. Such being the case, a reduction in bulk of any article represents a potential saving. Again, by way of illustration, let us see what transportational economies may be effected by taking much of the water out of 3,660,408,000 pounds of whole milk so that the concentrated product is only 40 per cent. as heavy as the raw milk from which it is made. The extraction of the water cuts down the freight burden by nearly 1,100,000 tons. In other words, the milk condensed last year served to shorten the milk train by fully 35,000 cars.

Conservation of this nature, besides preserving a highly perishable foodstuff, makes it possible to add to the daily dietary of many millions of people something essential to their bodily well-being.

SAVING EYESIGHT IN INDUSTRY

THERE is a coördinated movement afoot, under the guidance of Federal authorities and engineering and educational agencies, which has for its purpose the conservation of the eyesight of the Nation's citizens; and this work deserves all possible encouragement.

The problem is not merely one of pointing out how accidents to the eyes may be avoided, but it is equally important that care be taken to detect at the earliest practicable moment any inherent defects of vision lest these become aggravated by unconscious neglect.

Not long ago, Doctor EARLE B. FOWLER, acting for the American Engineering Council's Committee on Elimination of Waste in Industry, reported that in the United States the total number of industrial blind approximated 15,000, or 13.5 per cent. of the total blind of the population, and he emphasized that the personal loss from blindness is far greater to the individual than from other kinds of defect. He revealed that the eye was involved in 10.6 per cent. of all permanently disabling accidents.

Again, sub-standard vision is a fruitful source of trouble; and in some lines of employment it has proved a heavy handicap to efficient production. For instance, in a certain rubber company twenty per cent. of the inspectors were discovered to be unable to see well enough to determine manufacturing shortcomings! Another concern, after having the eyes of all of its employees examined and glasses fitted, obtained a 28 per cent. improvement in plant output within two months. And a third big enterprise learned, after examination, that 58 per cent. of the personnel engaged in close work needed glasses to correct imperfect sight.

THE BUSINESS RECOVERY

RECENT business statistics show that there is a building boom which grows steadily; that automobile production was probably the second largest in the history of the industry; that oil production continues practically at its peak; that retail trade, as reported by the large department stores, was in volume at a very high point; that the stimulus to production, which began in February and March, has been sustained; that the strength of bonds and stocks continues to grow; that money rates tend to go down and that there has been no conspicuous tendency towards an extensive expansion of commercial loans by the banks.

These conditions are directly contrary to the prevailing expert opinion which existed about a year ago. In one of the largest banks in New York all of the officers, from the president down, were unanimous in stating that the year 1922 was likely to be one of the most trying in our history.

Yet we are contending with various big strikes and with a condition which shows no material volume of increase in manufactured exports. We were told a year ago by economists, who spoke with emphasis, that no great recovery could take place in the United States until conditions in Europe were changed. We were also told that it was only through greatly reduced freight rates that business would recover, and that wages must come down.

Business in the West has been stimulated by the unusual rise in prices of farm products, just as an increase in the price of cotton has produced an improvement in the South. Stocks of sugar, steel, copper, and of other lines, have steadily diminished, and loans have been paid off or reduced, though the volume of bank credit still continues to be about twice what it was before the War. The real danger in

that we may enter upon another period of inflation. In other words, we may go too fast. The limit is the buying power of the world.

HOW THE COMPRESSOR HAS PUT THE TINKLE IN THE TUMBLER

ONE WHO traveled upon the Hudson a score of years ago and who takes another trip to-day upon that river cannot fail to notice the decrease in the number of ice-houses along the banks and the emptiness of some of those still standing. Relatively few of the latter were filled last winter although the season was unusually favorable for ice harvesting. The year before, however, gave little and short opportunity for ice gathering, and that is one of the inevitable uncertainties of the business.

And yet the domestic and other uses of ice have vastly increased, indeed, are growing continually; and the business of supplying ice is, despite seasonal vagaries, one of the most reliable. This sounds like a paradox; but when we consider the matter in detail the situation, thanks to engineering progress, becomes understandable.

Natural ice is not to be had for nothing any more than is the power from a great waterfall. The ice must be gathered and stored by an expenditure of labor, and there is the added cost of the ice-house and associate appurtenances. Next, there are transportational charges, and these mount up when the ice, as so often is the case, must be moved considerable distances. Finally, there is the item of constant wastage between the harvesting period and the commodity's ultimate disposal.

To-day, the artificial production of ice is a permanently established industry; is of vast proportions; and is growing at a great rate. Regardless of the actual cost of the refrigeration, the process has its incidental advantages, and these really determine its great success. Long distance transportation and bulky storage are eliminated at once. The ice is made at or near the point of consumption; and it is turned out in quantities to meet immediate demands. These factors make the vast regions of civilization a market for refrigerating machinery, especially so where natural ice has not hitherto been procurable or where, for this reason, the ice-using habit has consequently not been developed.

If to the direct uses of ice are added the artificial refrigeration of practically all edible products for protracted storage or for distribution far and wide, we see how machine-made ice must supplant natural ice except for essentially local purposes. Climate, no matter how torrid, cannot offer a serious obstacle to the artificial production of ice.

Most of us know what the process of artificial refrigeration essentially is, and how alternate compression and expansion of suitable gases induce thermal reactions which are capable of lowering the temperature of a brine mixture, for instance, a goodly number of degrees below Fahrenheit zero.

Taking mechanical refrigeration in its broadest applications, the story is a fascinating one of technical achievement in the face of many difficulties; and elsewhere in the current issue we deal with some aspects of this very important phase of modern engineering. R.

WHAT IF IT SHOULD COME TRUE

THIS MAY be the last appearance of this publication—at least for a while, if the prophecy of a Philadelphia geologist comes true.

Doctor MILTON A. NOBLE, of the City of Brotherly Love, has forecast the eruption of 70 volcanoes in the general neighborhood of Budapest; and when these break loose in September the resulting earthquakes will wipe out Southern Europe, Northern Africa, a large part of Asia, and the whole of the Pacific coast of the United States.

True, we are reassured by Doctor BIGOURDAN, the Director of the Paris Observatory, that the Pennsylvania scientist is probably exaggerating, but we might just as well be prepared for the worst and ready to face some of the problems of readjustment which will be forced upon us when so much of the world's dry land sinks beneath the flood of the predicted cataclysm. The economic questions arising out of the recent period of armed strife will be trivial by comparison; and yet, with a more restricted foothold for man, may it not be possible for the survivors to come to a better understanding and recognize the benefits of universal fellowship?

"Asia for the Asiatics", as a slogan, will be on a par with Atlantis for the Atlanteans—assuming that the dwellers of that mythical isle wished to hold aloof from the rest of humankind. "Sunkist" fruit will become only a tradition; the Golden West will be a glory of the past; the Pyramids will be no more to vex the archaeologist with the manner of their building; and Latin Europe, the beckoning torch to the tourist and the home of the insidious grape, will no longer tempt us to its genial shores.

But what if reaction equal action, and the remaining terrestrial realm mount skyward as the inundated regions sink? Some millions of us may find our lot a harder and a drier one than now. We may have to hustle desperately even for water; coal may be at a fourfold premium; our railway tracks may be a tangle of twisted steel; and for transportation we may have to look to the irrepressible "jitney." Doctor NOBLE is, no doubt, in earnest, but let us hope that he is wrong. We can get along without his cataclysm and settle existing difficulties if the earth's crust will keep decently still for a reasonable while.

MORSE—BELL—MARCONI

THE story of the life and the most notable achievement of ALEXANDER GRAHAM BELL, who died August 2nd, at the ripe age of 75 years, is told in the current periodicals with a comprehensiveness which it would be futile for us to attempt. The occasion, however, is one suggestive of serious thought, both reminiscent and broadly anticipatory.

The three names in our caption are those of a trio whose great mission has been to bring all the peoples of the earth into closer touch by facilitating speedy intercommunication. Each has worked, perhaps unwittingly, upon the successive stages of the one great development which is still in a process of evolution; and in the realm of epoch-making inventions no other three have so strikingly supplemented those preceding them in the same field. The work of MORSE and BELL is finished, while that of MARCONI is scarcely more than launched and gives but a hint of its ultimate possibilities.

It is not easy to realize how fast and how far these inspired workers have brought us along. The first definite sketch of the Morse telegraph scheme was made when sailing across the Atlantic before the days of established steam navigation. The first public exhibition of the Bell telephone, ready for service, was at the Philadelphia Centennial Exhibition, with Dom PEDRO, Emperor of Brazil, and Lord KELVIN among those then to be astonished by the revelation. The wonders of radio have come upon us so suddenly and the whole art is still in such a state of flux that only the first chapter of the story can now be written.

And yet each of these great inventions, like most others, is only a stepping stone and not a permanent landing place. The telephone is already largely superseding the telegraph, at the same time it has brought about hundreds of new employments of its own; and what radio may do to render wires superfluous we can as yet but guess.

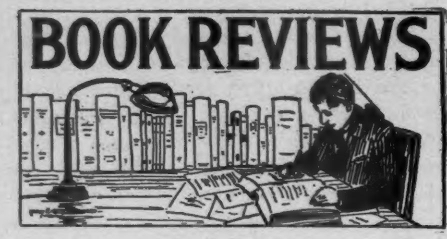
That no man's work unceasingly holds the world's attention in no way detracts from its value and importance. There is never a laying of a last stone upon the ever climbing structure of our civilization, but all good work counts just the same in the enduring mass. Doctor BELL found for himself a special job: he did it well, and all of humankind are the richer for evermore. R.

ALL PUFFED UP OVER THEIR POTATOES

Aroostook County, Maine, dominates the northeastern section of the Pine Tree State, and the denizens of that well-to-do part of the country are bent upon having the county break away from Maine and establish itself as a separate State in New England.

Since 1900, Maine has grown more than 30 per cent. in population and 300 per cent. in valuation, so we are told; and there is no disputing the fact that Aroostook County has played no inconspicuous part in boosting the State's prosperity. Indeed, the county is one of the most important agricultural districts in the country; and for years has ranked as the foremost potato-producing area of the world. If Maine had not been the pioneer, decades back, in the prohibition movement one might be justified in concluding that the lucrative tuber had in some way gone to the heads of the Aroostookites.

Mr. Eugene P. McCrorken, until recently editor of COMPRESSED AIR MAGAZINE, has left to take up other work. We wish him all possible success in his new field of activity.



HANDBOOK OF THE PETROLEUM INDUSTRY, by David T. Day, Ph.D., Editor-in-Chief, and a staff of sixteen of the country's foremost experts. The work is in two volumes, profusely illustrated, cloth bound, and of 2070 pages. Price, postpaid, $15.00. New York City: John Wiley & Sons, Inc.

THIS PUBLICATION is said to be the most comprehensive book so far written on the subject of petroleum, and is a veritable treasure house of information. It should be valuable to every branch of this many-sided industry. For years, the impending shortage in the supply of petroleum has been seen well enough by petroleum producers and refiners; it has required, however, the experiences of the past few years to arouse general recognition of this situation. Repeated appeals have been made to petroleum investigators for greater energy in searching for new supplies, as well as for more careful utilization of the stores which have already been found. The Handbook has been inspired in the main to help in these directions. The authors have not hesitated to point out possible advances in the industry, though still somewhat in the future. They emphasize that undoubtedly the feature of the industry which most needs exposition is modern practice in refinery construction, and to this phase of the business they have devoted considerable space. While the work has been primarily written for the enlightenment of the public, nevertheless especial thought has been given to the needs of engineers who produce and refine oil.

EXPORT PACKING, by C. C. MARTIN with chapters by D. T. Abercrombie, formerly Lt. Col. Quartermaster Corps, U. S. A.; H. N. KNOWLTON, formerly Captain, Ordnance Dept., U. S. A.; M. C. FITZGERALD, Mgr. Transportation, General Electric Co. A guide to the methods employed by successful shippers. Illustrated, indexed, 710 pp. $10.00. New York, Penn Terminal Bldg., 370 7th Ave. The Johnson Export Publishing Co.

THIS VOLUME represents a practical summary of the problems of packing for export and how successful shippers have arrived at the solution of the difficulties. This book not only tells how but shows how to pack any kind of merchandise, as it contains more than 350 reproductions from photographs of successful packing methods and drawings with complete details of dimensions and construction. Among the many practical hints given are the selection of woods, marking of package, bale construction, protection from rust, avoidance of high duties, test cases and crates, and also useful information regarding nails, seals, straps, and water proofing, as well as a great many more items too numerous to mention.

The purpose of the book is not to solve all the problems of export packing but to discuss the necessity of good packing and its relation to the whole export industry; to suggest certain rules which, if observed, will produce a proper export package; and to present a sufficient number of concrete examples to serve as guides both in the administrative office and in the packing shop. The author has apparently demonstrated within the limits of his text that the transportation of goods is as important as the production of goods.

METRIC SYSTEM FOR ENGINEERS, one of The Directly Useful Technical Series, by Charles B. Clapham, Lecturer in Engineering and Elementary Mathematics at University of London-Goldsmith's College. 181 pp., with conversion charts and numerous illustrations. Cloth. $6.00 postpaid. New York: E. P. Dutton & Company.

THE CONTROVERSY regarding the legal enforcement of the Metric System both in Great Britain and in the United States has been much in evidence in latter years, while the actual use of the system in industry has been steadily increasing—especially because of closer international coöperation among engineers during the World War. As the author expresses it, "In view of this wider application it was felt that there was room for a book giving a full and practical explanation of the system in so far as it is met with in engineering calculation and measurement, and which would be of use to draftsmen, mechanics, and others who deal with calculation and measurement in detail."

The object of this book, then, is an explanation of the Metric System from the technical point of view, without intending to advocate its compulsory adoption. The book will, undoubtedly, be found of much practical help to the busy worker who is obliged, from time to time, to resort to conversion tables. In connection with the measurement of length, special attention has been given to the usual measuring tools met with in drawing-office and workshop that may be graduated in metric units, e. g., verniers, micrometers, and planimeters, numerous examples in reading being given by means of illustrations.

The following new publications have been issued by the U. S. Bureau of Mines:

TECHNICAL PAPER 268. Preparation and uses of tar and its simple crude derivatives, by W. W. Odell. 1922. 84 pp., 4 pls., 11 figs.

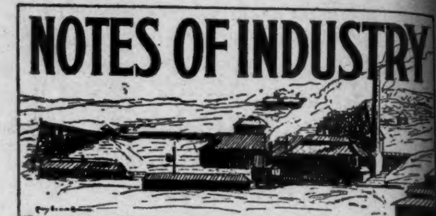
TECHNICAL PAPER 295. Quarry accidents in the United States during the calendar year 1920, by W. W. Adams. 1922. 68 pp.

TECHNICAL PAPER 297. Accidents at metallurgical works in the United States during the calendar year 1920, by W. W. Adams. 1922. 28 pp.

TECHNICAL PAPER 298. Methods for testing petroleum products, by the Interdepartmental Petroleum Specifications Committee. 1922. 58 pp., 21 figs.

TECHNICAL PAPER 299. Metal mine accidents in the United States during the calendar year 1920, by W. W. Adams. 1922. 99 pp.

TECHNICAL PAPER 305. Specifications for petroleum products, by the Interdepartmental Petroleum Specifications Committee. 1922. 40 pp.



Important new Spanish hydro-electric installations may be divided into two groups, according to the U. S. Commercial Attaché at Madrid, one lying in the Provinces of Lerida and Gerona and aggregating 146,500 horsepower, the other centering at the falls of Dos Aguas and at those of the Cinca in the Aragonese Pyrenees. An estimated total of 300,000 horse-power of hydro-electric installations were underway in Spain at the beginning of 1921, of which the plant of the Riegos y Fuerzas del Ebro, at Camarasa Falls, Lerida, was finished during that year. Power from both of these groups is transmitted to Barcelona at a voltage of 110,000.

Hydro-electric resources of Spain in actual exploitation at the beginning of 1922 are estimated at from 500,000 to 600,000 horse-power. This is only about one-tenth of the potential energy possible of development.

It should be of interest to manufacturers and exporters of well-drilling machinery, equipment, and supplies to know that from the year 1904, when the first artesian wells were drilled in the Philippines in an experimental way, to the end of 1921, when the popularity of this work had become an undisputed fact, a total of 1,369 successful artesian wells were drilled and brought into operation, supplying potable water to a large portion of the inhabitants. Under normal conditions, the Philippine Islands should offer an excellent market for well-drilling machinery, equipment, and supplies.

Modern conveniences are forcing their way to the front in the Holy Land. The British Government has granted concessions for the establishment of two big hydro-electric plants along the banks of the River Jordan; and from these installations the City of Jerusalem will be supplied with current for light and power purposes. It is estimated that 1,000,000 horsepower can thus be generated and that water can be impounded by the dams in sufficient measure to irrigate 1,200,000 acres of the neighboring land. The execution of the undertakings will give direct employment to 3,000 men and indirectly open up fields of activity for a much larger number. About $5,000,000 will be required to carry out the projects.

Recently several people have been killed by gas fumes generated by gas stoves in the city of Pittsburgh. The Bureau of Mines, at its experiment station in that city, has undertaken an investigation to determine the products of combustion from house-heating stoves of different types. Samples of natural gas have been taken in various sections to determine the quantity of carbon monoxide produced.

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